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FIG. 1. COMBINED VIEW AND SECTION OF GORGE IN HUDSON RIVER, AT STORM KING CROSSING OF CATSKILL AQUEDUCT; SHOWING EXPLORATORY VERTICAL AND INCLINED BORINGS, SHAFTS AND TUNNEL.

(On March 3, 1911, shafts had been sunk to tunnel grade and tunnel driven from each shaft as indicated. East shaft is being sunk below tunnel about 40 ft., as sump, to receive unwatering apparatus whenever tunnel may be emptied. Middle hole, under scow in river, reached depth of 768 ft. Upper inclined holes passed at 955 ft., and lower inclined holes passed at 1,500 ft. below river surface. Grade tunnels pierce Breakneck and Bull Hill Mountains 400 ft. above river level, and Moodna pressure tunnel, 220 ft. below river level, skirts northerly toe of Storm King Mountain.)

The Hudson Tunnel of the Catskill Aqueduct for the Water-Supply of New York City.

By ALFRED D. FLINN,* M. Am. Soc. C. E.

Probably no feature of the works for obtaining from the Catskill mountains an additional supply of water for New York City has attracted more popular attention than the crossing of the tidal estuary of the Hudson, about [illegible] miles north of the city. To determine the location of this crossing, 25 miles of the river—10 miles above and 15 miles below the city of Newburg—were explored geologically and by topographical surveys and borings. As a preliminary boring operation, 226 wash holes were put down on 14 cross sections of the river and supplemented by a number of diamond drill holes. In 1907, the Storm King crossing, about four miles below Newburg and four miles above West Point, was tentatively adopted, and since that time has been very thoroughly explored by vertical drill holes from the river surface, inclined borings in the rock shores, test shafts on the two shores, and inclined drill holes from chambers in these shafts.

As a result of these explorations it has been

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finally decided to cross the river by means of an inverted siphon, or pressure tunnel, in the solid rock, 1,100 ft. below the river surface, driven horizontally between two vertical shafts 3,022 ft. apart. The shafts have been sunk to grade and the tunnel started from each. Both shafts and tunnel are to be lined with rich Portland cement concrete, so that they will have a finished interior diameter of 14 ft. Fig. 1, which is a combined view and section of the river gorge, shows the general arrangement of the borings, shafts and tunnels.

The West Shaft will be a downtake connecting with the pressure tunnel extending westerly five miles, under the valley of Moodna Creek. This tunnel enters the Hudson shaft at an elevation 228 ft. below the river surface. At the completion of the work this shaft will be securely sealed with masonry at its top.

The East Shaft will be a combined waterway and drainage shaft, and from it, at an elevation 185 ft. below the river surface, a tunnel extends under Breakneck Mt. to another shaft which rises in the mountain to hydraulic gradient, a little over 400 ft. above the river. Since the East Shaft is to be used for unwatering the tunnel, its top will be closed by a heavy cast-steel cover, very securely bolted in place, but removable whenever it may be necessary to install the pumping apparatus to empty the tunnel. At the top of this shaft there will be a blowoff, by which water above the river level can be discharged without pumping.

The preliminary explorations were described in Engineering News of April 2, 1908, and the progress of the core borings were further recorded in some detail in Engineering News of April 7, 1910, which told of the first pair of inclined holes from the shafts and the method of drilling them. Additional details can be found in two papers in the "Proceedings of the Municipal Engineers of the City of New York," the first by Robert Ridgway, Department Engineer, Northern Aqueduct Department, in the volume for 1908, and the second by Assistant Engineers Samuel D. Dodge and William B. Hoke, in the volume for 1910.

All told, at the Storm King crossing, 15 vertical holes have been drilled from the surface of the river, and one vertical and two inclined holes from the surface of the rock at the shores, making a total of 18, aggregating 6,631 ft. in length. On the east shore the hole was inclined 32° 24′ from the vertical and reached a depth of 221 ft. The inclined hole on the west side was 24° 4′ from the vertical and 566 ft. deep. In both cases the holes were about 25 ft. from the water's edge. Of the 15 holes in the river, 6 reached bed rock; the others were abandoned before reaching rock, because of accidents from passing vessels or insuperable difficulties in sinking through the glacial drift. The last hole—exactly in the middle of the river—reached a total depth of 768 ft., when it had to be abandoned in December, 1910, because of the weather and other difficulties, without reaching bed rock. Hence only a partial rock profile has been determined, and not even the location of the probable lowest part of the rock gorge fixed. The river holes aggregate 5,625 ft., of which 4,656 ft. are in drift, 767 ft. in water and 202 ft. in bed rock. Drilling explorations were carried on for five working seasons. The final hole was occupied for two seasons. It was started with 18-in. casing and reduced by telescoping to 2½-in.

From this prolonged and unusually difficult marine boring work experience has indicated what is a suitable equipment for such operations. During the latter part of the work the Phoenix Construction Co., the contractor, used the following:

One 35 × 100-ft. pile-driving scow with ways 60 ft. high.
One 40-HP. hoisting engine with two 7 × 10-in. cylinders, and two 12-in. drums.
Two 12-in. × 7-in. × 12-in. pumps of 100 gals. per min. capacity at 120 lbs. pressure.
One 60-HP. boiler.
Casing and wash pipe made of 18-in. and 14-in. welded steel pipe and 10-in., 8-in., 6-in., 4-in., 2½-in. and 2-in. extra heavy wrought-iron drive pipe with screw joints and long sleeve couplings.
A strongly built diamond drill machine with 1⅜-in. rods and enough diamonds for two bits.

After sealing the casing in the ledge rock, a platform was clamped to the top of the casing and the drilling machine mounted thereon. A 20 × 30-ft. scow tender (Fig. 2) was anchored close by, carrying a pump and boiler which were connected to the drilling machine by flexible hose. Owing to the great depth of water, the casing was held from falling over or being pushed over by four guys with heavy anchors. Fig. 3 shows the drill platform clamped to the top of the casing and the small scow used when drilling in bed rock.

For removing obstructions, such as cobbles and boulders, encountered by the casing while it was being washed down through the drift, large quantities of explosive were used, mostly 60% Forcite. In difficult cases 93% nitroglycerine was employed. Owing to the great hydrostatic pressure in the deep holes a special exploder was necessary because the plugs of ordinary exploders were forced in so as to break the fuse bridge. Charges varied from 4 to 20 sticks of Forcite, and several exploders were placed at different points in each charge.

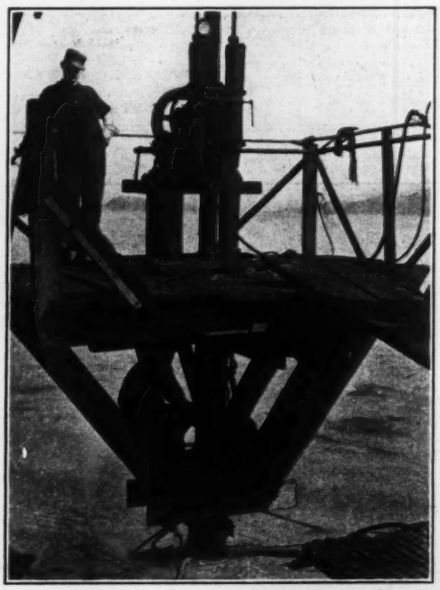


Fig. 2. Diamond Drill Mounted on a Platform Supported by Guyed Casing to Which It Is Clamped.

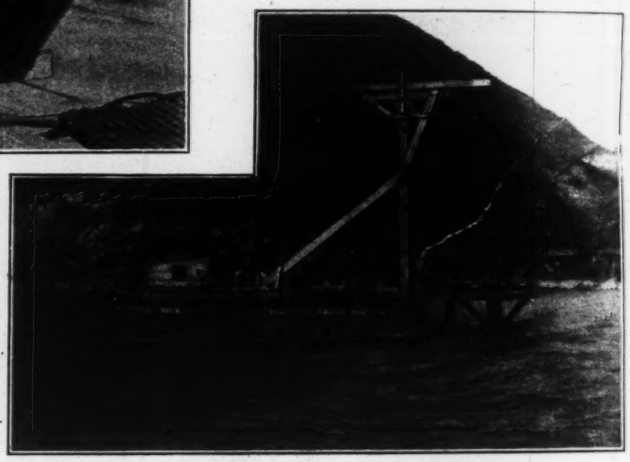


Fig. 3. Diamond Drill Platform Mount, With Scow-Tender Carrying Boiler and Pump.

FIGS. 2-3. MAKING A DIAMOND DRILL BORING BENEATH THE HUDSON RIVER, ON LINE OF CATSKILL AQUEDUCT.

From the first it was recognized that vertical holes alone would not be sufficiently complete means of exploration, because even if conditions had been such as to make it possible to space these holes reasonably close together, and sink them rapidly, there would still have remained the possibility that a troublesome seam or fault in the rock would not have been discovered. So great was the importance of this link of the aqueduct that a complete transverse examination of the rock was necessary. For this reason a shaft was sunk on either shore and diamond-drill holes, inclined at relatively flat angles, driven to intersect under the middle of the river. Fig. 4 shows one of the drilling machines used for driving the inclined holes, as set up in the chamber excavated at one side of the shaft.

When the article of April 7, 1910, was written, the first pair of inclined holes from the [illegible] had just been completed. Very soon [illegible] under a second agreement, Sprague & Hen[illegible] of Scranton, Pa., began a second pair of inclined holes from the same chambers, which were intended to intersect at a depth of about 900 ft. below the river surface, the endeavor being [illegible] to locate these holes as to skirt closely to [illegible] portions of the rock surface profile as [illegible] known but still to remain in rock, unless [illegible] unforeseen crevice or gorge should be encountered. These holes were finished in August, 1910, with lengths of 1,651.4 ft. from the East [illegible] and 1,652.1 ft. from the West Shaft, and [illegible] at a depth of 955 ft. At the top the inclinations below the horizontal on the east and west sides, respectively, were 22° 53′ and 23° [illegible] at the bottom, 23° 35′ and 25° 55′. In the east hole the rate of drilling per 8-hr. shift averaged [illegible] ft., and in the west hole, 5.9 ft. The east hole was 4 ins. in diameter for 8.5 ft.; 2¾ ins. in diameter for 715.5 ft., and 2 1-16 ins. in diameter for 927 ft., the sizes of core and percentages recovered being for the three stretches of hole respectively: 3-in. core, 78%; 2-in., 84%; [illegible]-in., 48%. For the west hole the corresponding figures are: length of 4-in. hole, 7 ft.; 2¾-in. hole, 772 ft., and 2 1-16-in. hole, 873 ft. The percentages of core recovered were 76, 83, and 68, respectively, the core diameters being the same as in the east hole.

Almost no water was encountered in the west hole, but the east hole discharged at the finish 120 gals. per min., which was considerably less than the lower east hole described in the 1910 article. The total elapsed time of drilling was 122 days, and the working time 85 days of three 8-hr. shifts for the east hole, and 127 days elapsed time and 107 days of three 8-hr. shifts for the west hole.

No conditions were revealed by these holes which indicated other than favorable prospects for the tunnel.

Besides the pressure tunnel in solid rock, several other schemes for crossing the river were considered, the more important being: (1) several lines of steel or iron pipes, laid in trenches in the river bottom; (2) one or more tunnels driven with pneumatic shields in the glacial drift deposit forming the bottom of the river; and (3) a bridge with one or two spans. All of these would be more expensive, less permanent, and in other respects much less satisfactory than the rock tunnel.

As now being driven, the tunnel will be wholly in sound granite, 150 ft. below the elevation of the crossing of the upper pair of inclined holes. Between the level of this crossing and the bottom of the deepest hole, in the middle of the river, lie 185 ft. of unexplored ground, of which at least a part must be rock. Hence there is a

very abundant provision for withstanding the bursting pressure due to the hydraulic gradient being 300 ft. above the river, for the simple weight of the slice of rock directly over the tunnel is more than sufficient at the shallowest place in the river. The exploratory borings have proven that the rock will be of excellent character from the shaft, and that probably but relatively small quantities of water will be encountered.

The East Shaft is 90 ft. from the water's edge, the natural surface at its top was 31.5 ft. above it; the West Shaft, 110 ft. from the water, with its top 40 ft. above it. Excavation of the East Shaft has brought the present surface immediately around the shaft mouth down to Elev. 10. The shafts were so sunk that if, as confidently expected, the rock proved of satisfactory character, the shafts could be made a part of the permanent work. Under an agreement, the Cranford Co., of Brooklyn, sank the East Shaft to Elev. —249, and the West Shaft to Elev. —226, suspending work Dec. 7, 1907. Subsequently the Board determined to complete the shafts under the immediate direction of its engineers, and for this purpose organized the necessary forces and secured additional equipment. Delay necessarily resulted, so that the work of shaft-sinking was not resumed, after unwatering, until March 3, 1909, on the east side and May 30, 1909, on the west side.

The shafts were timbered as they were sunk and are being equipped with cages ready for tunnel-driving. A contract is being prepared for completing the tunnel excavation and placing the concrete lining so as to finish the shafts and tunnels between the tunnels being constructed under other contracts on each side of the river. It is intended, however, to continue work with the Board's forces until the contract shall have been advertised and the contractor is ready to begin work. Throughout the depth of the shafts, the rock has been sound and on the west side very little water has been encountered, the maximum rate of flow to date being only 30 gals. per min. In the East Shaft a maximum of about 350 gals. per min. was encountered when the wettest diamond drill hole was still open. When the drill holes had been closed, the flow was reduced to about 140 gals. per min. To care for these quantities and be prepared for a very much greater flow, if it should be encountered, pump chambers have been excavated in each shaft at approximately Elevs. —400 and —800, large enough to hold three Jeanesville duplex plunger pumps, 16 × 7 × 18-in. The full number of pumps has not yet been installed.

In the lower parts of the shafts a phenomenon which has been locally termed "popping" of the rock has occurred frequently. Assistant Engineers Dodge and Hoke, in their paper, already mentioned, describe this as follows:

> Without warning there will be a loud report like a pistol shot and a piece of rock from the wall will fly into or across the shaft. Usually the fragment is small and does no damage, but at times such fragments have caused injuries of minor nature. This popping may occur from rock surfaces which have been uncovered several days. It has not been very frequent and was first noticed in the West Shaft at Elev. —450.* Prof. W. O. Crosby has explained the phenomenon as an explosion resulting from the local relief from mechanical pressure to which the rock is subjected by the wedge-like structure of the granite underlying the river. He says:
>
> The relief will, normally, find expression either in scaling or in the development of cracks or rifts, which, tending to be parallel with the east and west sides of the shafts, will rather seldom be subject to direct observation. I may add that this is a fairly common happening in mines and quarries. Often in quarries the compressive strain is measured by an appreciable stretching of the rock when released, so that it would be impossible to force a block into the space which it formerly occupied. This phenomenon of spontaneous snapping and rifting has recently been described as occurring in some of the deep Lake Superior copper mines. That it was not observed nearer the surface in the Hudson River shafts is probably due to the relief long since afforded by the erosion of the gorge of the Hudson. It should not be regarded as jeopardising appreciably the security of either shafts or tunnel and it is evident that we have here a powerful agent tending to tighten and close up seams in the granite.

Popping was more frequent toward the bottoms of the shafts. As a protection, steel lining consisting of plates and rings of channels has been promptly placed as shaft-sinking progressed.

For unwatering the Hudson siphon the same scheme has been adopted as for the Rondout, Wallkill and Croton siphons; two vertical, multi-stage centrifugal pumps, with electric motors mounted above them, will be installed in a steel cylindrical float, which, starting at the top of the shaft, will sink to the bottom as it pumps the water from the shaft. As the float sinks, lengths of discharge pipe will be added at the top, and when the float reaches the bottom, it will rest upon concrete pedestals in a sump at such depth that the top of the float will be below the invert of the tunnel. After completion of inspection or repairs, the tunnel can then be slowly refilled with water and the float will rise to the surface, the sections of discharge pipe being disconnected and removed. Probably it will rarely be necessary or desirable to empty this siphon. Owing to the clearness of the Catskill water, its long sedimentation in the great Ashokan Reservoir, screening and aeration, and flow through 47 miles of aqueduct to reach the Hudson, there will be very little, if any, deposit in the deep tunnel. Furthermore, velocities of 2.5 to 6 ft. per sec., corresponding to the probable usual minimum and maximum quantities flowing through the aqueduct when in service, are not conducive to sedimentation.

The blowoff near the top of the East Shaft will make possible the discharge of water from the aqueduct above river level for long distances on either side of the river, if this should be desired. This blowoff will work under a head of about 400 ft. It has been estimated that a 40-in. valve, of special design, in the blowoff pipe will be large enough to discharge the full capacity of the aqueduct. Its outlet will be submerged in the river. The valves will be in duplicate and the velocity through them when discharging at maximum rate has been estimated at upwards of 100 ft. per sec. To be sure such discharge will be rare.

On top of the drainage or East Shaft there will be a concrete chamber approximately 60 ft. sq., with a suitable superstructure fronting on the river, to house the drainage equipment and valves. Owing to the steepness of the mountainside, the situation here is quite congested, for, in the 80 ft. between the river and the chamber, is the main highway along the river, and back of the chamber the two-track main line of the New York Central & Hudson River Railroad, which here emerges from a short tunnel through the nose of Breakneck Mt. To complicate the situation further, the railroad company proposes to construct two more tracks between the present tracks and the chamber, necessitating a second tunnel through the mountain, thus placing within 100 ft. from the building four railroad tracks, with necessary clearances.

The Hudson siphon is in the Northern Aqueduct department, under the general supervision of Department Engineer Robert Ridgway, with William E. Swift, Division Engineer, in immediate charge. Mr. J. Waldo Smith is Chief Engineer, and Mr. Merritt H. Smith, Deputy Chief Engineer of the Board of Water Supply. The designs were prepared in headquarters department, by Designing Engineer Thomas H. Wiggin, under the general supervision of the writer.

FIG. 4. DIAMOND DRILLING MACHINE IN POSITION IN CHAMBER AT SIDE OF SHAFT SINKING INCLINED HOLE AT HUDSON RIVER CROSSING OF CATSKILL AQUEDUCT.

SEVEN HIGH-TENSION SUBMARINE CABLES were recently laid under the Harlem River, New York City, for the Union Railway Co. operating largely in the Borough of The Bronx, but having its power-house in Manhattan These cables have each three No. 0000 B. & S. gage, stranded conductors and weigh 18.7 lbs. per ft. of length. The working potential is 6,600 volts and the cables were tested at 30,000 volts in the factory and at 20,000 volts in place. They were made and laid by the Waterbury Co., of New York City. The work was described in the "Electric Railway Journal" Feb. 25. On account of previous trouble from tangled cables it was decided to lay all seven cables simultaneously, keeping them 1 ft. apart throughout. A 75-ton steam lighter was used to transport the reels and to hold them while laying. The Bronx ends were made fast first. On account of shallow water, the lighter could not approach within 70 ft., so that it was necessary to use a lighter boom 90 ft. long and equipped with three sets of hoisting falls. A pulling line was strapped to the cable for about 25 ft., and led to the shore station, through a snatch block, and back to a gipsy engine on the lighter. As the cable end was hauled out the boom and falls were run out and lowered to the proper entrance level of the cable house. When the cable end reached the house ducts the first of the straps holding the leader was severed and the others were successively cut as the cable was fed into the house. Crossing was made during slack high water, which lasts about 15 minutes. Two tugs pushed the lighter across while the cable was paid out, the reels being controlled by timber brakes on the flanges. The crossing required some ten minutes. Care had to be used, in landing the Manhattan ends, not to bend the cables too much and to keep their relative positions. Each reel was lifted by the boom to free the cable end. Each end as freed was lashed to a shore line and the cable was dropped into place over an empty reel on deck. When all seven were so freed the supporting reel was lifted with fixed boom; the lighter was then moved back to clear the cables as the boom was lowered. While the cables were being so deposited, the shore ends were hauled up. The final reel was removed and each cable was run into its duct, after strapping to a leader, much as at the Bronx side.

The Morris Dam of the Waterbury, Conn., Water-Supply Extension.

The city of Waterbury, Conn., formerly obtained its water-supply from several small reservoirs, widely separated and of limited yield. Nearly 20 years ago it became necessary to seek an entirely new source of supply. The West Branch of the Naugatuck River, in the towns of Thomaston, Watertown, Morris and Litchfield, was selected for the purpose. About 10 miles northwest of the city a system of reservoirs was laid out, involving the ultimate construction of three dams, with sufficient storage capacity for a city of 200,000 population.

The first of these, the Wigwam Dam, a masonry structure, was completed in 1902; it was described in Engineering News of May 7, 1903, by Mr. R. A. Cairns, M. Am. Soc. C. E., City Engineer of Waterbury, under whose direction it was designed and built. Since that time, however, the growth of the city has been so rapid that extension of the supply is already necessary. The present population of about 75,000 (1910) represents an increase of 50% since 1900. A year ago, therefore, work was started on the construction of the second dam of the system, the Morris Dam.

The Morris Dam, now under construction, is located on the same stream as the Wigwam Dam, a little more than a mile farther upstream. In distinction from the latter, however, it is an earth dam with concrete core-wall, a study of the conditions and available material having proved an earth dam to be most economical. Its greatest height above the surface of the valley will be about 100 ft., and its length 1,100 ft., including the waste weir. When completed it will add a storage of 2,000,000,000 gals. to that afforded by the present Wigwam reservoir.

The foundations of the core-wall rest on a ledge of solid rock extending across the entire width of the valley. On the side slopes, rock is at a depth of but a few feet from the original surface, while in the center of the valley the foundation pit had to be carried down to a depth of about 45 ft. by the use of steel sheet-piling. The excavation on the whole length of the core-wall was carried down to sound rock.

The core-wall is 12 ft. wide at the base and up to El. 425 (from city datum), above which it has a batter of 5/8-in. to 1 ft. on each face, as shown in Fig. 1. It is composed of 1:3:6 concrete up to El. 482.6 where the width becomes 6 ft.; from this plane to the top of the wall, a height of about 35 ft., a 1:3:5 mixture is to be used. The top width is 2 ft. 5 ins. In the heavy part of the wall, as well as in the head-walls and gate-house foundations, clean boulders or "plums" may be used. There is no reinforcement in the core-wall except at vertical joints, where sufficient 1-in. twisted steel bars, 8 ft. long, are laid across the joint to take care of temperature stresses and prevent cracks while the wall is exposed.

The foundations of the head-walls, gate-house and spillway, located at the west end of the dam, also rest on solid rock. The head-walls are composed of 1:3:6 concrete, except where less than 5 ft. thick, when a 1:3:5 concrete is to be used. They will have a uniform thickness of 2 ft. 6 ins. at the top, and a 15-in. coping. The batter of the outside face is 1 to 20; on the fill side 4 ins. to 1 ft.

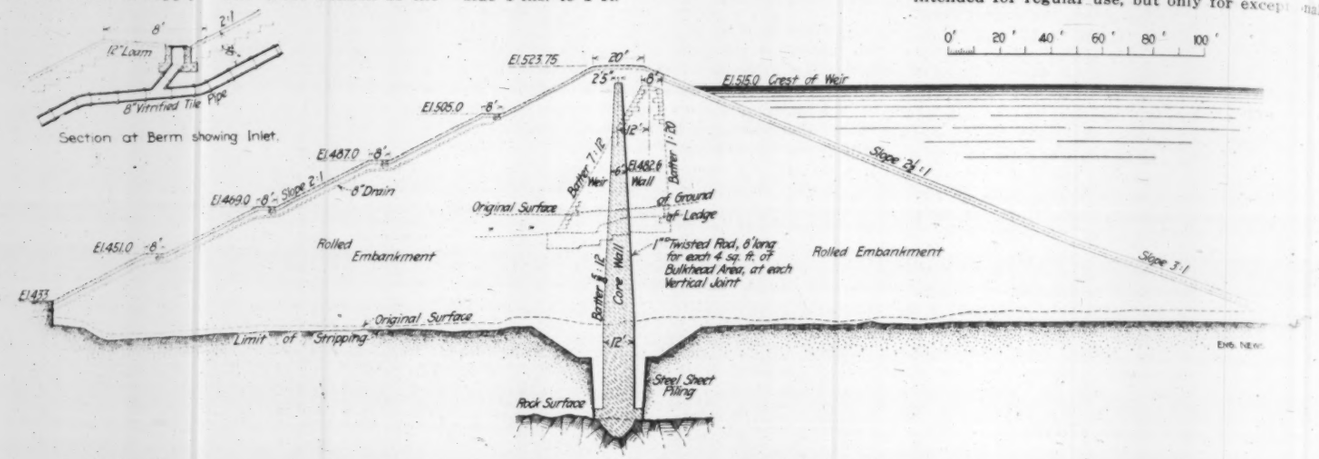


FIG. 1. MORRIS EARTH DAM OF THE WATERBURY, CONN., WATER SUPPLY EXTENSION; MAXIMUM SECTION.

The spillway is shown in Fig. 1, on the section of the dam, in dotted outline. The batter of its upstream face is 1 to 40 (not 1 to 20 as shown in the original plans) and of its downstream face 7 ins. to 1 ft. The crest has a total length of 200 ft. and is at El. 515.

Concrete blocks are used for facing all exposed surfaces of concrete in the spillway, head-walls and gate-house foundations. These blocks are from ½ to ¾-cu. yd. in size and made of 1:3:5 concrete. The faces are made smooth by casting on metal plates inserted in the forms, and have their corners rounded to about ½-in. radius. The blocks must be seasoned for at least three months before use in the walls.

A reinforced-concrete drain tunnel, about 34 sq. ft. in section, is located on the ledge at the foot of the western slope. This takes the normal flow of the creek during construction. It leads into the downstream gate-house. Three 24-in. pipe connections are made with this tunnel leading into the present city main from the Wigwam reservoir, and with a blow-off into the lower reservoir. These gates, however, are not intended for regular use, but only for exceptional occasions when the water should become very low, or when it may become necessary to draw off the reservoir.

The earth embankment is shown in maximum section in Fig. 1. Its bottom width at this point is about 500 ft. Its upstream face has a slope of 3 to 1 for a height of 30 ft. and the upper part of 2½ to 1, paved with 18-in. stones laid on a 12-in. bed of crushed rock. The toe of the pavement, throughout its entire length, rests on a concrete foundation, about 3 ft. square in section, bedded normal to the line of pressure. The downstream face has a slope of 2 to 1, and is sodded and drained as shown in the profile, Fig. 1. The berms, 8 ft. wide, have a slight inclination inwards and are graded longitudinally towards the drain openings, which are 12 × 30 ins. and about 18 ins. deep, with 6-in. concrete walls. They are covered with iron gratings. The drains are located east and west of the center of the dam and are shown on the plan, Fig. 3. Each is built of two 8-in. tile pipes laid parallel to each other.

For making the fill an excellent hardpan is obtained at a distance of a few hundred feet from the western end of the dam. The fill is made in regular layers, not exceeding 6 ins. in thickness on the upstream side of the core-wall, and 8 ins. on the downstream side. According to specification requirements the difference between the fills on the two sides of the core-wall at any time during construction must not exceed 2 ft. below El. 460, and not more than 1 ft. above this plane. The embankment is thoroughly wet and rolled with 10-ton steam rollers with grooved or banded rolls. No stones larger than 4 ins. in diameter are allowed to go into the upstream fill, and none larger than 6 ins. in diameter into the downstream side. Around the core-wall and head-walls selected material, hand-tamped, is used.

The service gate-house is on the western end of the dam on the head-wall between the embankment and spillway, as shown in Fig. 2. It has six 30-in. intakes leading into two intake wells, two intakes being at El. 460, and one each at Els. 471, 482, 493 and 504. They are provided with separately operated gate valves

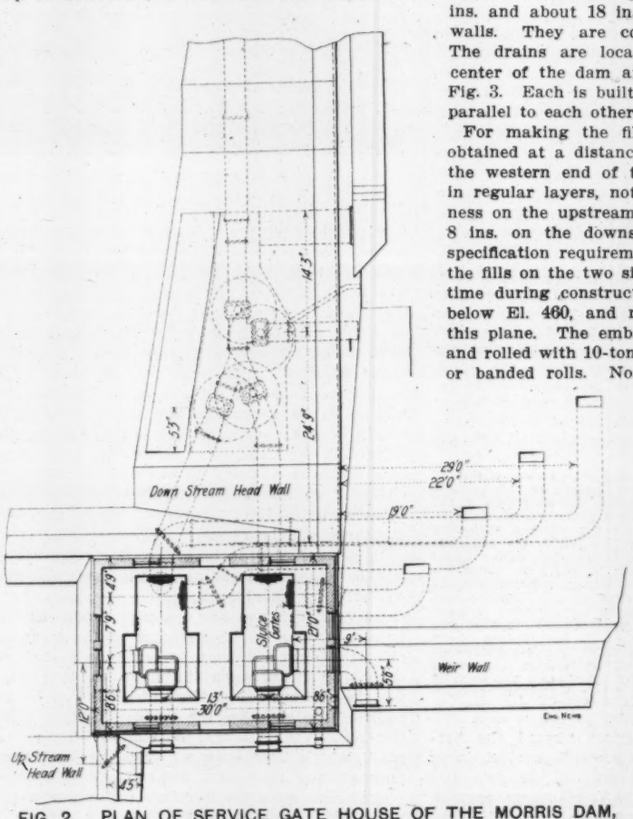


FIG. 2. PLAN OF SERVICE GATE HOUSE OF THE MORRIS DAM, SHOWING HEAD-WALL GATE CHAMBER.

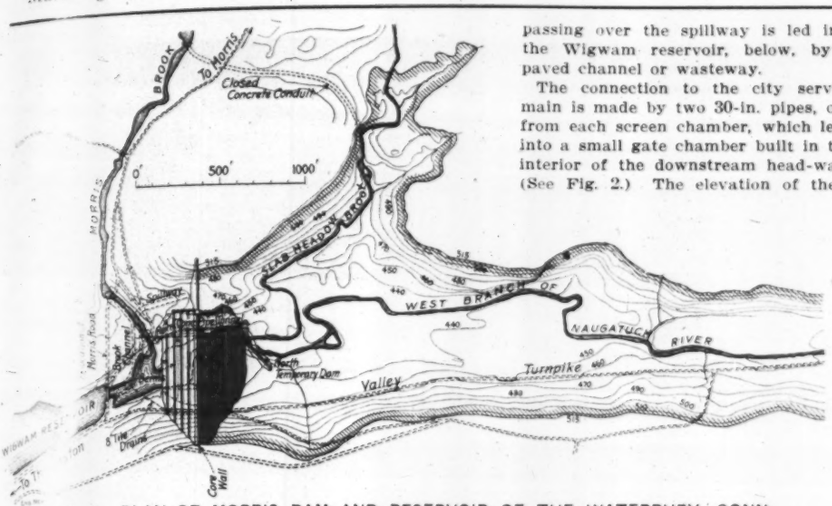


FIG. 3. PLAN OF MORRIS DAM AND RESERVOIR OF THE WATERBURY, CONN., WATER SUPPLY.

Screens at the middle of the wells divide them into intake chambers and screen chambers. Leading from the screen chambers are four outlet pipes passing through the spillway dam and opening on the downstream face at Els. 470.86, 481.91, 492.92 and 503.96. This arrangement of inlets and outlets at various elevations is made in order that the purifying effect of aeration on the water tumbling over the spillway may be utilized as fully as possible. The water thus passing over the spillway is led into the Wigwam reservoir, below, by a paved channel or wasteway.

The connection to the city service main is made by two 30-in. pipes, one from each screen chamber, which lead into a small gate chamber built in the interior of the downstream head-wall. (See Fig. 2.) The elevation of these inlet gates is 458.75. Within this chamber reducers from 30-in. to 24-in. pipe are used. A 24-in. Y connects the two inlets to the 24-in. city service main. This main, however, wherever it is bedded in the concrete, is made of 30-in. pipe in order to provide for future increase in demands for water. In the chamber there is a 24-in. blow-off connection to the wasteway. The chamber is sufficiently large to allow for the operation of four 30-in. gate valves, although at present only 24-in. valves are used. This reduction in the size of valves, the 24-in. being sufficient for all present demands, means a considerable saving in first cost. The chamber is provided with an 18-in. ventilating duct and an entrance from the wasteway protected by a concrete fender and iron door. Six-inch drain pipes are provided for both gate chamber and intake wells.

The arrangement of gates is somewhat complicated by the two uses to which the reservoir is to be put; one use being simply that of furnishing additional storage to the present reservoir, and the other to furnish water from the new reservoir as a high-service supply by direct connection to the city main.

Owing to financial difficulties the original contractor was unable to complete the work. Therefore little progress was made after the fall of 1909 until the following summer. The corewall is now completed to a height of about 12 ft. above the bed of the valley and work on the fill was begun in the fall of 1910.

For the concrete masonry an excellent grade of washed sand, taken from the bed of the creek above the dam, is being used. A good grade of granite is found on the western slope of the valley, where a crusher plant and concrete mixing outfit have been established.

The dam was designed and is being constructed under the direction of Mr. R. A. Cairns, M. Am. Soc. C. E., City Engineer, to whom we are indebted for the plans and data given. The Resident Engineer is Mr. Charles W. Eddy, Assoc. M. Am. Soc. C. E. The contractors are The Ryan-Unmack Co., of New Haven, Conn.

FIG. 4. SITE OF THE MORRIS DAM, WATERBURY, CONN., WATER SUPPLY, LOOKING EAST.

A New Frog Device Giving a Continuous Rail for Both Tracks.

A frog device which will give a continuous rail for both tracks at railway turnouts (and especially those used at high speed) is a very desirable feature of track construction, but while several devices of this kind have been invented they have not been used to any great extent. At the intersection of the main and turnout lead rails it is necessary, of course, to break the continuity of the rails in order to allow of the passage of the flanges of wheels on either track. With rigid frogs, each wheel must pass over this break or gap, and the consequent shock is injurious to both the wheel and the frog, besides involving continual tamping and maintenance work to keep the track in proper condition.

Where one track is a siding, or is used much less than the other, it is now general practice in this country to use a spring-rail frog to remedy these conditions. This gives in effect a continuous rail for the main track, but has a movable spring-rail which is pushed aside by each wheel on the turnout. This arrangement is not available where both tracks carry an equal amount of traffic or where the turnout is used at high speed.

Devices for eliminating the gap in the rail at the frog and giving a continuous rail for both tracks (or for whichever track the switch is set) have been used for 25 years or more. Most of them provide an actually continuous or unbroken rail for the main track and have the turnout lead rail raised gradually so that at the intersection the flanges of wheels traveling on this rail will clear the top of the main track rail. A gap of several inches is left necessarily in the turnout rail to permit the passage of wheels on the other rail. As a rule, in these frog devices, this gap is closed (when the switch is set for the turnout) by a movable rail or casting which is operated simultaneously with the movement of the switch. Such elevation of the lead rail is undesirable (if not impracticable) for high-speed turnouts.

A frog-device which is now being tried on a number of railways is of an entirely different type from the devices mentioned above. It gives a continuous rail for whichever track the switch is set, and it requires no elevation of the lead rails. It consists essentially of a movable frog point, the heel being pivoted and the toe sliding laterally (like the switch rail of a stub switch) to engage with one or other of the lead rails, according to the position of the switch. The operating rods are so connected that both switch and frog are moved simultaneously to give the desired route. This device is designed especially for high-speed tracks and turnouts, as it eliminates the jar and impact of wheels on rigid frogs. There are no bolts on the moving part, except those for the attachment of the operating rods. No guard rail is required, such as is used with ordinary frogs (and most frog devices) to hold the wheels in proper position to pass the frog.

A view of this frog device on the Chicago, Burlington & Quincy Ry. at Burlington, Ia., is shown in Fig. 1. Here the frog or tongue (A) is set for the track (B-C), on which the locomotive is standing. With the tongue moved to the left, to connect with rail (D), it will be in position for the track (E-F). The general construction of the device is shown in Fig. 2; the upper view shows the parts assembled and the lower view shows the movable tongue removed from the base plate.

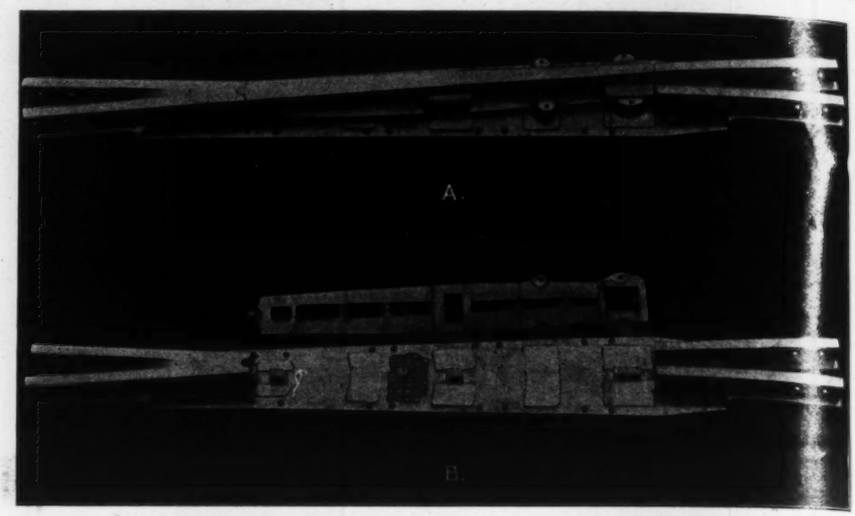


FIG. 2. CONTINUOUS-RAIL FROG; (A) ASSEMBLED; (B) MOVABLE TONGUE, REMOVED FROM BASE PLATE.

The device consists of two parts, each of which is a manganese-steel casting: (1) The base plate and rail end connections; (2) the movable tongue. If the frog connected directly with the lead rails, there would be liability of its not being set properly, due to lateral shifting or displacement of the independent rails (spiked to the ties), and to expansion and contraction of these rails. The former might result in the failure of the tongue to register or coincide exactly with the lead rail, while the latter might result in jamming the rail and frog or leaving a wide expansion gap between them. To obviate this difficulty, the base plate is made with rail ends forming an integral part of the casting, and to these the lead or track rails are spliced in the usual way. Thus the movable tongue registers with the rail connections cast upon the bed plate so that a closely fitted joint between the moving and fixed parts is permissible.

The movable tongue is hollow, or of bridge section, and slides on raised seats or bearing surfaces on the base plate. It fits over stops on the base plate (which limit its movement), and in this way it prevents dirt or snow from getting between the tongue and the stops so as to prevent the former from being moved to its proper position. The details of the parts of a No. 9 frog are shown in Figs. 3 and 4. The movable point has two end bearings or seats, with intermediate seats which are raised slightly above the end seats. The purpose of this is to avoid a fulcrum, which would otherwise be caused by a wheel entering upon the end of the movable point. This prevents tilting. The lug at the toe is so constructed as to prevent the movable point from rising. At the heel, there is a pin passing laterally through the moving point and the adjoining member of the base. These arrangements of the lug and pin prevent the point from rising at either end when a load comes upon the approach end.

The total length of the frog for a No. 9 turnout is 13 ft. including the rail connections; for other turnouts the length is increased correspondingly. The movable point for the No. 9 frog is 6 ft. 4 ins. long. This length is approximately the same for frogs of higher numbers, the center of rotation being shifted to a position determined by the intersection of planes passing through the centers of the rail heads. The movable point of the No. 9 frog is pivoted on a 1 in. pin. This, however, performs no work and serves simply as a guide. On frogs of higher numbers no pin is used, the lug at the heel of the frog on the bed plate forming the working member or pivot. The throw of the moving end of the frog point is 5 9/16 ins. The total weight

FIG. 1. A FROG DEVICE GIVING A CONTINUOUS RAIL FOR EITHER TRACK; CHICAGO, BURLINGTON & QUINCY RY.
(Continuous Rail & Safety Switch Co., St. Louis, Mo.; Makers.)

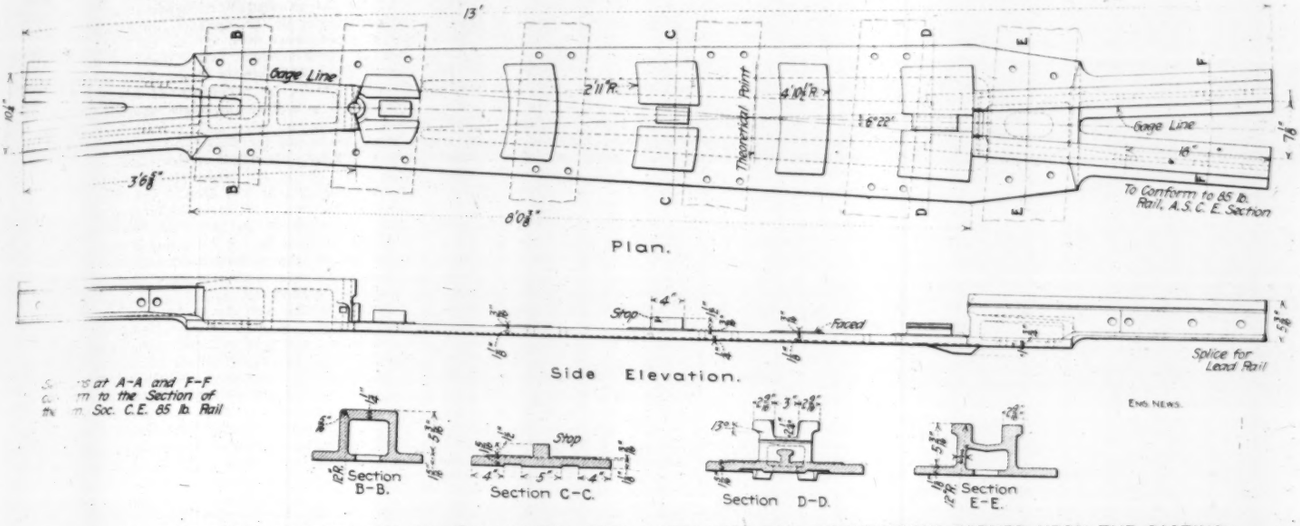


FIG. 3. BASE-PLATE CASTING FOR CONTINUOUS-RAIL FROG (WITH LEAD RAIL CONNECTIONS FORMED UPON THE CASTING).

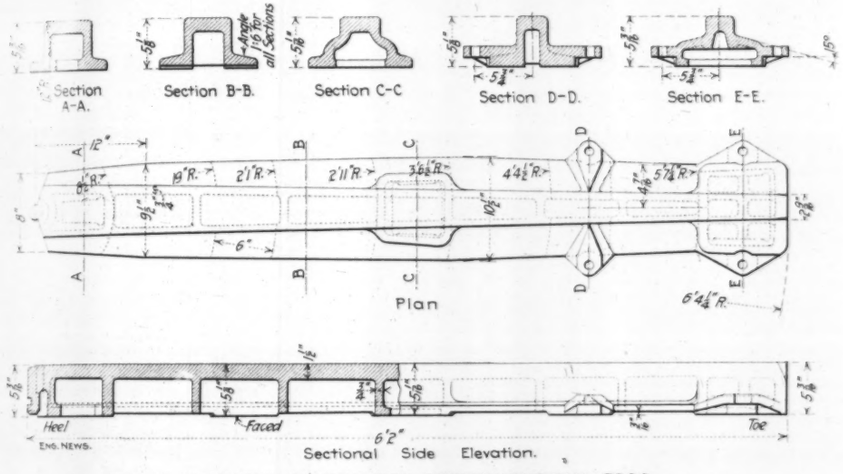


FIG. 4. MOVABLE TONGUE FOR CONTINUOUS-RAIL FROG.

of the No. 9 frog, made to fit rails of the Am. Soc. C. E. 85-lb. section, is about 1,500 lbs.; of this amount the movable point represents about 400 lbs.

The frogs first made were of the "automatic" type in which the movable point could be thrown automatically by the train. That is, with the frog set for one track, a train trailing through on the other track would set the frog for the latter. Some of the frogs made in this way are still in use. It was found, however, that railways did not favor this feature, and the frog as now made is locked rigidly in either position, being intended specially for turnouts equipped with interlocking. The possibility of throwing the frog while a train is passing is prevented by the use of mechanical detector bars or an electric detector. The latter is so arranged as to prevent the unlocking of the switch and frog while a train is within certain limits. The movement of the switch not only moves the frog but also operates the lock of the frog and the derail (if any) on the siding.

This device is the invention of Mr. H. F. Roach, of St. Louis. It is being introduced by the Continuous Frog & Crossing Co., 1408 Syndicate Trust Building, St. Louis, Mo. (of which company Mr. Roach is now Secretary).

The frog of the improved design is in use on the Baltimore & Ohio Ry., the Vandalia Ry., and the Chicago, Burlington & Quincy Ry., while other railways have placed trial orders. Mr. F. T. Hatch, Chief Engineer of the Vandalia Ry., stated (in January) that the device was installed about six months ago at the point where the Vincennes Division freight line leaves the passenger line, thus making a main track line in both directions through the frog. The frog is No. 15, giving a long easy lead and it is interlocked with home and distant signals. It is still in use and giving excellent satisfaction to both the track men and the train men. It is said to require no more work to keep up the track through this turnout than at any point in the track where there is no turnout, and as the rail is continuous the movement of the train through the turnout is as smooth and easy as if there were no frog. The Chicago, Burlington & Quincy Ry. states that two types of the Continuous frog have been placed experimentally, but that sufficient time to show results has not yet elapsed. The manufacturers inform us, however, that with a foot of snow on this road the frog has given no trouble.

A Manganese-Steel Frog Made of Rolled Rail.

The frog shown in the photograph at the bottom of this column is stated to us to have been in the track since Jan. 12, 1907, at the throat of the Port Jervis yard of the Erie R. R. at Port Jervis, N. Y., except during 43 days from Jan. 28, 1909, to March 12, 1909, during which it was taken out for exhibition purposes. The frog is considered to be good for about two more years of service. The usual life of an ordinary frog at this point is about five months.

While frogs of manganese steel have been extensively used during the past dozen years, they are so expensive to manufacture that their introduction has been limited on that account. In the frog illustrated, however, only the wing rails are of manganese steel and these are cut from rolled rails to the right length with a friction disk and require machining. The point of the frog is made of ordinary Bessemer rails. It is claimed that in ordinary service of such a frog the point will wear as long as the manganese steel wing rails.

From the experience gained with frogs of this type thus far introduced, it is claimed that they wear as long as eight to eleven ordinary frogs of Bessemer rail. One of them, placed in DeWitt

A FROG MADE WITH WING-RAILS OF MANGANESE STEEL.

yard of the New York Central & Hudson River R. R. Co. in 1907, was reported in November, 1910, as being still "in good condition with the exception of point which is somewhat worn, but not enough to cause removal," and in the opinion of the railway engineer "it is probable that the frog has outworn seven or eight of the Bessemer frogs."

Besides being much less costly than cast manganese-steel frogs, the frogs of the type shown in the photograph have the advantage of being "cut in" as easily as ordinary Bessemer frogs, since they are of the same design. They can be made to suit any track, as the rolled manganese rail is now furnished by the Manganese Steel Rail Co., of 30 Church St., New York City, in all standard sections.

Some Public Relations of the Engineer.*

By M. N. BAKER.†

It is man's opportunity to help those aggregations of his fellowmen which collectively make up the great complex of modern society. The obligation to give such help, to render *social service*, rests upon all professions and upon non-professional men and women as well. But because human society as now organized taxes all the resources of nature, social service falls in large and peculiar measure upon that class of men which directs and which restrains the forces of nature for the service of man. The opportunity is open to all; in fact, it is an inherent duty and privilege of citizenship.

PUBLIC HEALTH AND SANITATION.—The concentration of population and the remarkable growth of cities during the past 50 years have created many new and difficult problems. One of these involves public health and sanitation. It embraces such matters as public water-supplies, milk and other food supplies and the collection and disposal of various forms of city refuse, including particularly the disposal of sewage in such a manner as neither to cause a nuisance nor to endanger the purity of public water-supplies. In addition, there are sanitary problems connected with the construction and maintenance of pavements and roads, particularly since the advent of the dust-raising automobiles. These various problems fall, some to the city engineer and some to the municipal health officer, but there is not one of them which the engineer as a good citizen is not called upon to help solve. I do not mean by this that the citizen-engineer is necessarily to take a hand in working out these numerous problems in detail (unless he is serving in some official or professional capacity), but, because of his special knowledge and training, he should always take a greater part than the layman-citizen, particularly in the creation and guidance of public opinion.

To those who have not given the subject close attention it may come as a surprise when I urge that in many respects the engineer rather than the physician is best equipped by education and training to serve as executive health officer in many of our cities. I urge this not without first-hand knowledge. Seventeen years ago, on beginning service as a member of a local board of health in one of the suburbs of New York City, I, in common with my fellow members, found myself confronted with the duty of selecting an executive health officer. The common practice in municipalities both small and large at that time was to appoint as health officer some local physician who had time on his hands, either because he was young and as yet without much practice or else because, though old, he was for one reason or another without patients. The results as I observed them were that a physician of the older class who had failed in his profession also made a failure as health officer, while a bright young physician found himself in the usual difficulties which involve any man who tries to serve two masters; or in other words, found that there was a conflict between his duties as a private practitioner and a public-health officer. Moreover, I found that, since a large part of the work of the public-health officer deals with broad problems of sanitation, and since the education and training of the physicians have to do chiefly with the ailments and actions of individuals rather than of society at large, the engineer of that day seemed to give better promise of service as a health officer than the physician. An added reason for employing an engineer rather than a doctor as health officer in our case was that although our community was small we wished to employ a health officer who would devote his whole time to the work, and it was more feasible for an engineer to do this than it would have been for a physician.

In the past seventeen years the education of both the engineer and the doctor in public-health matters has vastly improved, but some of the best of our engineering schools give more attention to public-health matters than do the medical schools. However this may be, my experience of nearly two decades with engineers as health officers, combined with my observations of like service on the part of engineers for other boards of health, confirm me in the opinion that in the public-health service there exists to-day a great opportunity for social service by the engineer.

This opportunity is by no means confined to local boards of health. Besides the considerable number of engineers employed by local boards, all of our most progressive state boards of health have one or more engineers in their service, while some have large engineering staffs headed by well-known members of the American Society of Civil Engineers. It gives me particular pleasure to say that New York state has such an engineering staff, headed by such a man, and that the Chief Engineer of the New York State Department of Health began his professional career as the very first engineer health officer of the Board of Health of Montclair, N. J.

The United States has no comprehensive public-health service. Some thirty years ago we had a National Board of Health, and for it one of our foremost sanitary engineers, Mr. Rudolph Hering, made an investigation of the leading sewerage systems of Europe. For reasons which cannot be gone into here, our National Board of Health was short-lived, and repeated efforts to revive it have failed. Meanwhile various federal bureaus scattered through the departments of Agriculture, Interior, Commerce and Labor and the Treasury, have taken up a few important lines of public-health work, but with little correlation and some duplication. In a few instances unfortunate errors have been made when chemists or physicians have ventured into the province of the engineer. As many of you know, several bills for establishing a federal bureau or department of health were before Congress in 1909 to 1911, but none of them were enacted. The most promising of these, the Owen bill, proposed little more than the consolidation of all the existing federal health agencies, which would have been a great gain. The Owen bill neither recognized the engineer nor was given material support by the engineering profession, both of which facts are to be regretted. Eventually we will join the other leading nations of the world by establishing a dignified, unified and effective national health service. A large part of the work of such a bureau or department will deal with water-supply and sewage disposal as related to interstate streams, questions peculiarly within the province of the engineer. The engineer should do his part to arouse and guide public opinion in an irresistible demand upon Congress for a well-conceived, well-manned and amply-financed federal health service.

I have dwelt particularly upon the engineer in health-protective work because of my own personal experience and observation in that field. So far as numbers are concerned, there are, of course, to-day, and will be in the future, many more opportunities for engineers in other branches of the municipal, the state and the federal service than in the one which has to do with public health; but I can conceive of no greater opportunity for social service open to the engineer than in doing what he can to ameliorate the physical and mental suffering and agony incident to preventable disease, while at the same time contributing to the prolongation of human life.

CITY PLANNING.—A comparatively new work for the American engineer, and one affording fine opportunities for both high professional achievement and great service to society, is offered by city planning. Unfortunately, most of our cities have grown in the most haphazard way instead of being held by wise minds to systematic development. As a result, our streets are not designed, either in direction, relative widths or character of pavement, to the use of the traffic passing over them. Parks and other needed open spaces to afford air and recreation are either lacking or are not in coordination with local needs. Poorly planned and badly congested railway terminals exist in most of our cities as a result of entrusting their location and design wholly to the railway companies who own and operate them, whereas the municipality and the citizens should unite with the railways in planning railway terminals for the use of the public, which the terminals are really designed to serve.

TRANSPORTATION.—Transportation problems, both local and general, are also pressing for solution on every hand. Some of these are involved in the terminal problems already mentioned. Others are concerned in regulation of public-service corporations. One phase of the transportation problem in cities is closely related to city planning; the valuable aid which efficient, low-cost urban and suburban railway service may give to the solution of the congestion of population which is so serious a matter in all our large and even in some of our medium-sized cities.

REGULATION OF PUBLIC-SERVICE CORPORATIONS.—The engineer has many opportunities for both professional and social service through the regulation of public-service corporations, which has become so important with the multiplication of these services, and particularly with great aggregations and consolidations of capital and with the joining of master mind to master mind for the elimination of competition. Here the opportunity of the engineer lies both in the line of professional work and in the creation an ance of public opinion. Here, too, the engine nected with public-service corporations may co to social service by being himself amenable to opinion and guided by the larger interests of the good.

The time is not far distant when every state Union will have its public-service commission, a haps every one of the larger cities as well. E of these commissions will demand the services of many of the most competent engineers the cou fords, so numerous, so great and so complex problems involved in the valuation of the prop public-service corporations, the fixing of their r the making and enforcing of regulations for th convenience and safety.

RURAL WORK.—It should be remembered t rural districts also have their problems and af opportunities, and that, although perhaps in a s humbler way, the opportunities for social serv to the engineer throughout the length and bre this vast country are quite as numerous as tho sented in the cities.

THE ENGINEER'S PREPARATION.—To meet many and extremely varied opportunities for serv engineer must be a man of broad training, good ment, and particularly a man possessed of great dealing with his fellowmen. To become possessed of these qualities requires far more than four years of the hardest possible study of purely engineering subjects. Broader subjects should be taken up, including a thorough grounding in purely cultural studies designed for the elevation and broadening of the mind; also for direct practical service likely to be in requisition any day, a fair working knowledge of at least the outlines of such subjects as statistics, accounting, civics and sociology, in order that the engineer may gain a full understanding of the many complicated relationships between man and government and man and man.

No little experience and observation of the engineer, both as a writer and a speaker, combined with much reflection on the duties and opportunities of the engineer and the best ways of meeting both, lead me to conclude that one of the things which the engineer needs perhaps almost more than anything else is a perfect command of his native tongue. English is our most frequently used and most effective tool or implement. The engineer must be able to convince his fellowmen, whether as employers or as neighbors, of the soundness of his views and the rightness of his judgment. Sometimes he must do this in a written report, and sometimes in a public speech. In either case he must rely upon his skill in using his native tongue. He needs therefore to continue the study of English throughout the whole of his college course, and he should not for a moment think that he can drop that study even then. His command of English will be bettered by a command of some of the other languages as well. In fact, his usefulness as an engineer and as a member of society will be quite closely related to his general fund of knowledge, and particularly to the breadth and depth of his culture.

Much of the early neglect of English and of all cultural studies was due to a once common feeling, still held by many, I fear, that engineering is essentially and severely practical and requires of its followers no refinement of education. The same feeling has led and still leads many a student and young engineer to consider time spent in social gatherings as worse than wasted. A graver mistake could hardly be made. Not only social service, but professional success as well, make the ability to participate in social functions with ease and grace almost as important to the engineer as a good command of the English language. The possession of both enables the engineer to influence the individual and to mold public sentiment. Any material lack of either lessens, if it does not destroy, the power of the engineer to render social service by creating and guiding public opinion.

A recognition by the general public of the great services which the true engineer always stands ready to render to society is also needed if the engineer's talents are to be made most useful to the public. As a member of one of the newer professions, the engineer has not yet come into his own in this particular. Through centuries the doctor of medicine, of law, and of divinity have been looked upon as the guides and helpers of the people. The engineer to-day is needed as never before to serve the public, but, as most of you well know, a large portion of the public still regards the engineer as little more than a measurer of land and somewhat less than a first-class mechanic.

With the growth of our engineering schools in numbers, in the character of their instruction, and in professional inspiration, as well as with the broadening of the mental horizon of the engineer himself as he goes into practice and with his entrance more and more into the social life of his community and country, we may expect that engineering as a profession will be placed on a par with medicine and law, even though it may not rise quite to the heights of divinity.

*Extracts from an address delivered before the Clarkson Memorial School of Technology, Potsdam, N. Y., on March 17, 1911, under the title "The Engineer and Social Service." The address in full will be published in the Bulletin of the School.

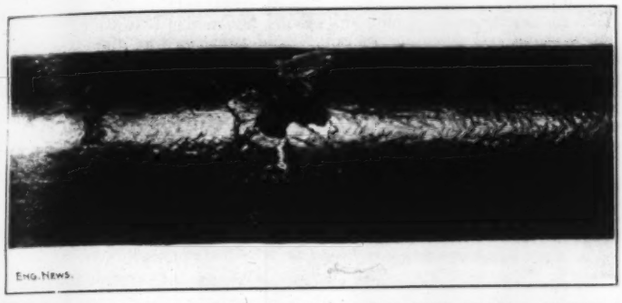
†Editor, Engineering News.

The Cause of Internal Corrosion of Hot Water Pipes.

M. J. FALKENBURG,* M. Am. Chem. Soc.

The author has been led to contribute these remarks on account of an experience almost identical with that reported by Prof. Ira O. Woolsen in Engineering News, Dec. 8, 1910.

We were recently called upon by Messrs. Howells & Stokes, Architects, to determine the cause of corrosion of the return riser pipes in the heating system of a high-class, modern office building on the Pacific Coast. The building has been completed about one year, but the trouble began a few months after steam was first turned on. Steam from a source outside of the building is used for heating. This steam is allowed to enter the system at a maximum pressure of 4 lbs. An oil separator is placed just after the valve to prevent oil being carried with the steam. The steam is carried by a system of parallel vertical risers, running from the basement to the top story, through the different rooms of the building—the rooms directly above each other being heated by the same steam riser. The steam passes from the vertical risers through a horizontal pipe to the radiator, where it condenses, and the condensed water, passing out through an automatic water-sealed valve, is carried by a horizontal pipe to the return riser, through which it descends to the basement of the building. All of the condensed water passes through a meter and into the sewer.



TYPICAL CASE OF CORRODED HOT-WATER PIPE FROM A SEATTLE INSTALLATION.

The corrosion first became apparent by the "eating-away" of the pipes at joints and where unions were located. Later some of the pipes rusted clear through, midway between the ends of the pipes, as shown in the accompanying photographs. Corrosion occurred only in the return portion of the heating system, and no trouble has been experienced in the steam risers. An examination of the inside of the pipes showed them to be pitted throughout their entire length and coated on the inside with a scale of rust, as much as an eighth of an inch thick in many places. When the scale was knocked out, the inner surface of the pipe was very bright, indicating that the action was continually going on. All of the corrosion took place from the inside of the pipes outward, indicating that electrolysis, from stray currents, was not the cause of the trouble. Notwithstanding this fact, numerous tests were made with a milli-voltmeter, to determine whether any current was flowing in the system, but in no case was a potential difference greater than 0.01 volt noted, and this was generally perceptible throughout the system when hot water was in the pipes.

Analysis of the condensed water revealed nothing of a sufficiently corrosive nature to cause the trouble experienced.

Several different theories were advanced to account for the disintegration, but it was finally decided that the corrosion must be due to some cause within the pipe metal itself. The opinion was strengthened because of the fact that a building heated from the same source, and in the same manner, and constructed some years before, had shown no such deterioration.

A sample of water caught where one of the defective pipes had been removed was found to contain considerable zinc in the form of oxides and carbonates. Analysis disclosed the presence of 0.3% zinc in a composite sample of the scale from the inside of several pipes. Most of the pipe in the system was ordinary black-iron pipe and no attempt was made to determine whether it was wrought iron or soft steel, other than the fact that it contained 0.6% manganese, which would indicate that it was soft steel.

An examination of the system was made to determine whether zinc was present in a form to produce serious galvanic action, and thus account for the presence of zinc in the scale and water samples. Several galvanized iron nipples were found, but these would not cause galvanic action to any considerable extent. The result of galvanic action between a galvanized iron pipe and an iron pipe in a hot water system is to produce a thin film of zinc oxide on the galvanized pipe, which protects the pipes from further serious corrosive action. In a zinc-iron electric couple, zinc is the metal attacked and not the iron.

Analyses were then made of several samples of pipe metal from different pipes in the return-riser system, and they were found to contain from 0.2% to 0.4% zinc. This remarkable circumstance, in our opinion, accounts for the corrosion that was taking place in the pipes, and may be the cause of similar cases of corrosion of the piping in hot water systems, that are being reported in other localities.

We would not consider the presence of zinc in wrought iron or steel possible under the ordinary conditions of manufacture. Not knowing the source of these pipes, we offer as a suggestion that they could possibly have been manufactured from billets to which scrap metal containing galvanized iron pipes or other zinc-carrying scrap had been added, and the mass only heated sufficiently hot to roll. A temperature of 1,040° C. is required to volatilize zinc, and it would not be necessary to heat the metal to this temperature for rolling. However this may be, the fact is that all of the several pipes analyzed from the return riser system contained from 0.2% to 0.4% zinc.

It is our opinion that this zinc is not alloyed with the iron or other metals in the pipes, but that it is present in the metallic state, and is diffused in minute particles throughout the pipe metal. We believe that each of these minute particles of zinc forms a galvanic couple with the adjacent iron whenever an electrolyte is present. The condensed water contained impurities sufficient to be an excellent electrolyte, and its ordinary hot temperature is ideal for this electrolytic action. The zinc being thus scattered throughout the entire pipe metal would cause the action to continue whenever any electrolyte was present, until the pipe was eaten through. We believe that the pipes gave away at the unions first, merely because they were thinner there from the threading. Zinc is the metal attacked in a zinc-iron combination, but its removal would cause mechanical and perhaps chemical disintegration.

Numerous cases have since occurred where a hole was eaten through, midway between the ends of the pipe where the ends were not greatly affected, as shown in the accompanying figure. We believe that in those places where the pipes were eaten through very quickly there was probably a comparatively large "pocket" of zinc. In this connection it is worthy of note that the pipe metal of the steam risers contained no zinc, and they were not appreciably corroded. Neither was any zinc present in the pipes of the return-riser system in the building similarly heated and mentioned above. We have made a large number of separate analyses on different pipes and we have found zinc in the metal of all of the badly corroded pipes. We are willing to submit samples of these pipes to anyone desiring to make either chemical or micrographic studies of the metal.

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The Durability of Welded Steel Pipe.*

By F. N. SPELLER.†

In again opening this much-worn subject it is my intention to touch on the results of recent investigations which it is believed have a most practical bearing on this important matter.

Before proceeding, let us for a moment review the fundamental reactions involved in the corrosion of iron, so as to have a clear conception of what is going on when, as we say, a pipe rusts. The most satisfactory explanation of corrosion is that iron is slightly soluble in water, a property common to nearly all materials in nature. In itself this is not of serious consequence, since the quantity dissolved is so extremely small. Moreover, when iron is dissolved the water gives up an equivalent amount of its disassociated hydrogen, which is, so to speak, plated out on the surface of the iron, causing electric polarization and retarding further solution of the metal. Solution is also retarded by the water becoming saturated with ferrous hydrate.

If we are dealing with water free from dissolved oxygen or acids, an equilibrium is thus soon established, but if oxygen is present it combines with the free hydrogen on the surface of the iron, exercising thereby a depolarizing effect and allowing more iron to go into solution. The ferrous hydrate in solution is also oxidized to insoluble ferric hydroxide and precipitated as rust, thus leaving room for more iron to pass into solution. Therefore, provided a continuous supply of oxygen is at hand, corrosion continues until the pipe is destroyed. Other things will accelerate the reaction, such as the presence of stray electric currents, galvanic action on the surface of the metal, the action of acids, etc., but practically speaking, in the case of water pipes the amount of corrosion is nearly proportional to the quantity of oxygen brought in with the water, so that water free from dissolved gases is usually quite harmless and will not even discolor the bright surface of iron after years of exposure. It also holds true that air free from moisture is equally inactive and will not cause rusting. We are not now concerned with this phase of the problem.

The elementary reaction of corrosion being one of solution, the physical condition of the metal, uniformity in composition, and the nature of the protective coating evidently have an influence on the solubility of iron and, therefore, on the rate at which rust will form. These are points which the leading interest in the manufacture of steel pipe has paid considerable attention to for several years past, since the practical significance of these things has been better understood. It is important to remember, however, that solution starts on the surface, and therefore that accidental differences in the condition of the surface may be much more influential in promoting solution of the metal than impurities in the metal itself. This applies particularly to mill scale, which forms with iron a galvanic couple having a potential many times greater than the worst possible case of segregated or irregularly distributed impurities found in the metal.

Many who have observed the increased destruction of piping and other metal products nowadays have concluded that there must be something radically wrong with the material of which these things are now made. A few years ago the cry was raised, and it is still maintained in some quarters, "Give us wrought-iron, so that the pipe will last." On the other hand numerous experiments have been made by independent authorities under conditions fundamentally those of service, which, on the whole, show no practical difference between wrought iron and steel, although these tests have indicated some important principles which should be observed in the manufacture of steel where corrosion has to be considered. There are many cases where wrought iron has been in service 30 years, and others where equally good wrought-iron did not last two years—and much wider ranges of life are on record. What, then, constitutes a satisfactory test? The wrought-iron interests say the materials must be in service for many years until they are destroyed. We agree that this is desirable provided that both materials have been in continuous service together, as the pipe may last 50 years or but 50 days in service, depending on surrounding conditions; experience based on other than such strictly comparative cases is worthless and misleading. The author, knowing that in the past 15 years iron and steel pipe have been made and sold side by side, undertook some investigations to learn whether the iron and steel had been by chance installed together in the same lines. Obviously, this would give an ideal comparison, especially in the case of water lines.

Let us consider for a moment the results of a study of pipe removed from hot water supply lines in the New York City baths which was undertaken by Professor Ira H. Woolson, formerly of Columbia University, now Consulting Engineer of the National Board of Fire Underwriters.[1] Briefly, he found that out of 88 pieces in

*From a paper presented at the annual meeting of the American Society of Heating and Ventilating Engineers, New York City, Jan. 24, 1910.

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([1]Engineering News, Dec. 8, 1910.)

eight bathhouses, which had failed through corrosion, 17 were undoubtedly wrought-iron, a larger proportion than might be expected judging by the relative proportion of wrought iron to steel on the market. In cases where pieces of iron and steel were removed from the same line they were found to be equally corroded.

We recently had an opportunity to examine the boiler feed-water pipe at the mines of the Frick Coke Co., which had been giving trouble in this way. Means were found to identify the pipe without removing it from the system. As anticipated, we found a number of cases where wrought-iron and steel pipe had been put together several years ago. Samples of such pieces were removed and cut open for examination. The data when studied show that both kinds were corroded much alike under similar conditions, except that the pits were slightly deeper on the average in iron than in steel.

In order to learn if there was any relation between the quality of the material judging by the chemical analyses and the local pitting due to corrosion, we selected two pieces of what turned out to be wrought-iron pipe from the same line, one sample of which (No. 44) was comparatively free from corrosion, while the other (No. 45) was badly pitted all over. The analyses of drillings taken from these samples are given below:

	Sample No. 44.	Sample No. 45.
Phosphorus	.160%	.120%
Manganese	Trace	.13%
Carbon	Trace	Trace
Oxides	2.95%	3.40%

In another case a piece of wrought-iron was found to be pitted in a few places, but by far the larger portion of the inside surface was free from corrosion. Analyzing the pitted and the clean surface we found the following composition:

	Sample No. 1		Sample No. 2	
	Around pits.	Clean surface.	Around pits.	Clean surface.
Sulphur	.023%	.019%	.021%	.020%
Phosphorus	.370%	.310%	.337%	.315%
Manganese	Trace	Trace	Trace	Trace
Carbon	Trace	Trace	Trace	Trace
Oxides	2.75%	3.00%	2.80%	3.00%

This does not indicate any significant difference in composition. The explanation for the difference in effect on materials like the above which have practically the same composition is evidently that the surface exposed to the water was in one case better protected than in the other by the mill scale which naturally forms in the process of manufacture.

Generally speaking, these figures and inspection of the interior of these pipes show that there would be nothing to gain by using wrought-iron. A similar case of comparison in a cold-water line was found in a greenhouse near Pittsburg with the same results.

We recently had an opportunity to investigate the piping in an apartment in New York City where they were having trouble with the leaking of hot water lines which had been in service about six years. The second or third piece examined proved to be wrought iron and was in poor condition. Other samples taken from the same system through which water had been continually circulated were found to be steel and show somewhat less pitting. This intermixture of iron and steel pipe can be explained by accidental intermixture in the manufacturers' or jobbers' stocks, and appears to be quite general.

An investigation of piping in New England is now being conducted in the Research Laboratory of the Massachusetts Institute of Technology at Boston by Dr. W. H. Walker, working along the line outlined above. It is believed that much valuable information may be obtained in this way and the results certainly should be free from the criticism which have been made against most of the experimental work done on this problem, viz.: that the conditions were not strictly those of service and that the time of exposure was too short.

PREVENTION OF CORROSION IN PIPES.—If the trouble is not due to the material, why is corrosion so much more serious nowadays, and how can conditions be bettered? Going back to the principal factor in corrosion, viz.: the air dissolved in water, it has been found that oxygen is more soluble than nitrogen, so that the proportion of the two gases in solution is about two volumes of nitrogen to one volume of oxygen, instead of five of nitrogen to one of oxygen as in the atmosphere. Pure water at normal pressure will dissolve 14.7 parts per million of oxygen at 32° F. and 7.60 parts per million at 86° F. At 210° and normal pressure oxygen is practically insoluble, so that by heating the water the solubility at normal pressure becomes less. But as water is usually heated in closed heaters under pressure, the gases are forced to remain in solution and in this condition the water may be said to be supersaturated. It is quite possible that in this state the oxygen is very active and more so the higher the pressure. On drawing off hot water from such a line into a glass, the gas is released and may be readily seen. Experiments have shown that under normal pressure water and air are most active in corrosion between 140° and 180° F. Evidently, if much more hot water is now being put through service lines (particularly in large hotels, apartment houses, and factories) we must expect a proportional increase in corrosian. If three times as much hot water is being run through a pipe of given size under the same pressure and temperature, the pipe, instead of lasting 21 years, will only last about seven years.

Knowing, as we now do, something of the cause and principles of prevention of corrosion, it should be possible for engineers to do much to remedy this state of affairs. Apparently, there is as little need of corrosion in pipes and tubes around boilers and in hot water heating and supply systems as there is for smoke from a modern power plant. The author is now trying out a system of removing dissolved gases from water by heating the water to a sufficiently high temperature, preferably under normal atmospheric pressure, and then passing the air-free water through a form of economizer designed like a closed feed water heater in which the excess heat in the air-free water is taken up by the cold feed on its way to the heater. This provides for a continuous supply of air-free water for service lines at any temperature. Another scheme for accomplishing the same purpose was proposed by the Royal Commission appointed to investigate the cause of corrosion in the Coolgardie (Australia) water-supply main. They found[2] after a thorough study of the situation that the steel main was suffering on account of oxygen dissolved in the water, and recommended that the supply be sprayed into vacuum chambers with the addition of three grains of lime to the gallon before passing into the pipe, and designed a plant for this purpose. Doubtless other means will be found to remedy the trouble when the economic importance of the problem is fully realized. Elaborate plants are provided for treatment of boiler water, which pay for themselves in a few years many times over, but so far in this country we continue to suffer loss in water lines, and as a rule, the responsibility is shifted onto the pipe manufacturer. Not that pipe cannot be improved, for steel pipe is now being made which is much better than that put out ten years ago, and even superior in lasting quality to the much talked of brands of wrought iron. Protective coatings more suitable for modern conditions are also possible, but why not endeavor to apply the obvious remedies and remove the fundamental cause of the trouble?

Some Impressions of America.

By W. FRANCIS GOODRICH,* Assoc. Inst. Mech. E., F. I. S. E.

According to one of the old proverbs of the Orient "A traveler without observation is like a bird without wings." In recording a few impressions and reflections of a recent journey, I feel that I am ill equipped for the task which the editor of Engineering News has imposed: not because I have failed to use the limited faculties of observation which I claim to possess, but mainly because the outstanding differences or contrasts between your great country and our "tight little island" are so great and bewildering to one who has been privileged to see so many features of a wonderful country for the first time.

I have not failed to observe that any really frank criticism of your country is usually resented, and that the multitude of writers who in the past have had the temerity to place on record their impressions of America, have invariably earned not a little opprobrium. Realizing this, all that it means, and what may be in store for me, I enter upon the task imposed. The fear of what will inevitably follow, shall not prevent me from being candid.

Unlike the famous Mr. Holt, of the London "Daily Mail," who expressed himself very freely, and even more definitely, concerning a thousand and one features of your country, after a stay of a few hours only, my remarks will be limited to those features or phases of your country in which I was especially interested.

After recording truthful replies to many terrifying queries such as: (1) Are you a Polygamist? (2) Are you an Anarchist? (3) Have you ever been in jail? one at length enters the New World, but only to find oneself in the merciless hands of the Customs Authorities. Having previously passed the Customs in most European countries, one is appalled by the exasperating thoroughness shown in New York. The German or even the Russian Customs officers are really painfully tame and indifferent by comparison with the aggravating energy of the Customs officers in the metropolis of the New World, the old traveler, however, finds it politic to be very friendly and helpful externally although [illegible] within.

Having cleared the Customs the happy traveler in his innocence goes joyfully forward looking for a vehicle to convey him and his sadly disarranged baggage to a hotel, but he is destined to fall into the hands of the Philistines or worse. He finds that the arrival of a Cunard liner is the harvest time for the independent chauffeur and his uncomfortable taxicab. For a journey of 1½ or 2 miles $3 is demanded, or fully four times the amount chargeable in London.

Arriving in New York at night one is struck with the number and size of the effective advertising devices in the form of huge electric signs, many of which are very ingenious while all are brilliant and attractive. Here I would state at once that I entirely disagree with the conclusions of Mr. Holt, the "Gulliver" journalist of the London "Daily Mail," who likened the appearance of Broadway at night to the Strand and Piccadilly in London. The truth is that London is practically devoid of the advertising instinct as exemplified in the remarkable electric signs of New York. As a matter of fact more can be seen in Moscow in this direction than in London. There is only one feature in common between the Strand and Piccadilly and Broadway at night and that is the cosmopolitan crowd to be found in all three thoroughfares. From every other point of view Mr. Holt might just as well have compared Broadway with the Nevsky Prospekt in St. Petersburg.

The scene in Broadway at night is undoubtedly without parallel anywhere, and the wonderfully fine electric signs clearly show that in this effective method of advertising the Britisher has much to learn, and it is just as well to acknowledge it.

While clearly recognizing the vital importance of rapid transit in and around such a city as New York, and while admitting that it is provided in considerable variety, on the whole it was disappointing. In comparison with London New York suffers. The electric underground railways of London and the electric tube railways are vastly superior to the underground railway in New York from every point of view: this applies also to the New York surface tramways, which cannot be compared with the tramway system and service of the London County Council.

As to the New York elevated railroad: well one simply wonders why and under what circumstances a great and free people permitted such an enormity to be perpetrated, to the disfigurement of many miles of their streets, while effectively shutting out light and air, both of which are theirs and theirs only.

The explanation of the existence and administration of the elevated railroad—often shamefully overcrowded, the subway cars, which with more "straphangers" than seated passengers, are yet never too full for more, and the surface railways, which may be placed in the same category, is simply this: that capitalists and monopolists have for some reason or other been able to get the upper hand of the New York citizen and the public interests have been ruthlessly sacrificed. To blame the municipality is not enough; it is the citizens themselves who are to blame.

An elevated railroad in London is an absolute impossibility; no one would dream of it; and why? simply because the streets are the property of the people. Herein lies the vital difference between London and New York: in London the people virtually control the monopolies, the railway companies realize that their first and foremost consideration must be the public; treat it well and dividends will be assured. In New York also the dividends are assured, but it is at the expense of the public from every point of view. The monopolists are the masters, they possess and exercise a power which in England they could neither obtain nor use. If they were able to get the best of the municipality they would have to reckon with the people and the people would eventually win.

In the regulation and control of vehicular traffic

[2] Engineering Record, May 21, 1910.

* Of Goodrich & Hamlyn, Engineers and Combustion Specialists, Clock House, Arundel St., Strand, London, W. C., England. Mr. Goodrich is a member of the Town Council of Watford, England, and Chairman of its electricity committee. He was for some years London engineering representative of Meldrum Bros., of Manchester, makers of refuse destructors, boilers and other steam specialties.

in the streets, it would be unfair to compare New York, Chicago, or any other American city with London, since it is generally conceded that in this London leads the world. At the same time it will not be out of place to observe that much remains to be done in this direction in New York. In repairs to roadways and in their cleaning there is much room for improvement. The City of New York does not compare favorably with the city of London from a cleansing point of view. Too much filth is permitted to accumulate. While cavities in the roadways of sufficient area and depth to cause serious accidents are comparatively few, some of these cavities are said to be very persistent. It is enough to remark that a system which permits of repairs of this kind being delayed indefinitely, is one which calls for some reorganization.

Now what shall be said regarding your steam railroads? In mileage and extent they are immense, the organization, in so far as freight handling and transit are concerned, is undoubtedly excellent: in this department even the best of the English railways might learn much.

The Pennsylvania Railroad station in New York is unquestionably the finest railway depot in the world, and the next best in Europe is a very poor second. When looking over this magnificent depot, however, one may be forgiven for asking a pertinent question: Is it a sound business policy to sink such an enormous sum of money in a railroad depot? Would it not have been possible adequately to provide for all the requirements of the present and the future, while spending far less money? One is forced to the conclusion that in connection with railroad depots, magnificent architecture does not spell dividends. Why go so far beyond the actual and reasonable necessities?

But to return to the railroads: how does America compare with England? I must confess that I was disappointed. In England we hear so much concerning the superiority of your railways. I traveled something over 3,000 miles and the superiority has yet to be demonstrated to me. In average speed there is perhaps but little difference between the best practice in both countries. In smooth running and in the permanent way we have a long lead. In comfort I think we may fairly claim to excel—that is for the ordinary traveler. Our fares generally are lower; our trains are more punctual; we have far fewer accidents. The Pullman sleeping accommodation provided is very poor by comparison with the ordinary sleeping accommodation of English railway companies.

To me it was a surprise to find that in connection with certain express trains between important cities, extra fares are charged, and not a nominal extra either. Now in England the fastest and best equipped trains in the country, such as for instance the Riviera Limited between London and Penzance and the best of the Scotch expresses, can be used by the ordinary third-class passenger without the addition of a cent to the ordinary fare. I must confess that after my experience of American railways my feelings towards the English railway directors have softened. Those who travel on the English railways certainly receive much more consideration.

Your railroad folders and railroad advertising generally reach a high standard. Here in advertising, again, we suffer by comparison. Looking over a folder, however, one observes the following: "The Electrically Lighted Knickerbocker Express," which sets one thinking. Can it be possible that the electric illumination of trains in the United States is so rare as to call for special notice and advertisement? In England electric lighting is common practice even in ordinary local or suburban trains.

To one engaged in municipal work in England, it was of great interest to observe on every hand unquestionable signs of an awakened civic conscience. The writer is firmly convinced that the future of municipal administration in the cities and towns of the United States will be based upon the best examples of local government to be found in Great Britain.

Politics and graft are doomed, and while like doomed men they may live a long time, yet it is certain that there is in sight a bright future for American municipalities: when he who is known as the politician will have no part in local government and when graft will be but rarely heard of.

While this evolution in municipal government is certain, the time and the complete fulfilment will depend entirely upon the citizens individually and collectively, it rests with them and them alone to say when the political opportunist and the grafter shall go. The process must inevitably be slow. The civic mind must be educated and this is not such an easy matter in a land of busy people. When once the citizen is convinced that the affairs of the town or the city wherein he lives are *his* affairs, then will come a drastic change.

That the great public utilities such as gas, water, and electricity should be outside the pale of municipal administration and control, is really opposed to the generally accepted ideas and principles of a great democratic people. When once it is realized that the public utilities should be owned, operated, and controlled by and for the people, the change will quickly come about. That this is fast approaching the writer is convinced.

The city of Columbus, Ohio, which the writer was privileged to visit, affords a striking object lesson as to what may be accomplished in this direction. Here is a city owning and operating its own electric generating station, water-works, and garbage reduction plant. Having for many years past made a close study of municipal ownership in England, it was a pleasure to find in the city of Columbus probably the "municipal mecca" of the United States. The municipal electricity, water and garbage reduction works in this up-to-date American city are worth a very long journey to see. There is a business-like keenness in their administration which may be very favorably compared with the best to be seen in England.

In the mayor, in the director of public service, in Mr. Irwin S. Osborn, who heads the garbage and refuse collection and disposal systems, and in Mr. Herman Gamper, the electrical engineer, the city of Columbus has men to be proud of; men whose well-directed energy and practical administration cannot fail to favorably impress any fair-minded person as to the economic soundness of municipal ownership. There is, however, a note of regret, and it is this: Is it right, is it not a striking indictment of the present system, that the work of these men and all that it stands for should be jeopardized by the swing of the political pendulum?

When one realizes that a change of party and the machinations of the politician may hamper and spoil the best work of this kind, one feels that there is no place for the politician or the party man in local government: he must go. The fundamental requirement of sound administration is a definite continuity of policy. This lies at the very root of the success of municipal work in England and will be found to be of equal importance in the United States.

The Socialist administration of the city of Milwaukee was of much interest to me, as indeed it must be to every student of local government. It was therefore a matter for regret that time would not permit of anything like a reasonable survey of the situation. It was a pleasant surprise to find that a "Bureau of Efficiency and Economy" has been established under a Socialist régime. In England whatever else the Socialist party may be credited with it is certainly not the desire or even the capacity for either efficiency or economy. In Milwaukee it is said they are cutting down the pay roll; in England they are said to stand for an unlimited pay roll.

If they are wise, those responsible for the local government in Milwaukee will realize that the opportunity is theirs to show not only the people of the United States but in every country what may be accomplished under a Socialist administration. If they do not fully realize their responsibilities, Socialism will receive a setback which will be felt in many countries.

It was my privilege to inspect the water-works of the city of Milwaukee, beautifully located on the shores of Lake Michigan, and it is but fair to say that in every respect these works are superior to many of the best water pumping stations in Great Britain. The design, layout and the efficiency of the plant, as well as the exceedingly satisfactory condition in which the whole works are maintained, reflect great credit upon Mr. McMillan, the chief engineer. It was interesting to learn that during the 37 years Mr. McMillan has been in charge of these works, the volume of water pumped daily has increased from an average of one million to forty-five million gallons daily.

Among such American cities as I visited none impressed me in quite the same vivid manner as Minneapolis. It is difficult to define one's feelings in visiting a thriving city of 400,000 people, when bearing in mind that 55 years ago the site of what is now a very remarkable city was an Indian Reservation. In Minneapolis, civic pride seems to pervade the very atmosphere. Every person one meets seems to possess a real pride in the city. Nor is it that distinctive pride peculiar to the citizen of Chicago, which seems to be measured by what can be got out of the city; it is a genuine and deeply-rooted civic pride of a kind which one likes to see, with nothing mean or sordid about it.

Owing to the kindness of Mr. Grant, editor of "The American City" of New York, I went to Minneapolis with a letter of introduction to Mr. W. L. Harris of the Publicity Club of Minneapolis. In Mr. Harris I found just that type of citizen who is bound to make a city go.

There can be no doubt that the Publicity Club has done a remarkable work in the fostering and development of the civic pride in this "City of Parks and Homes." The following titles of papers contributed to meetings of the club are extracted from the Year Book of 1910 and strikingly illustrate the methods adopted to arouse the citizen:

Advantages of Good Civil Government, by General Theodore Bingham, New York.
What Is a Governor Good for? by Governor A. O. Eberhart, Minnesota.
How Our Municipal Government Can be Brought Up to Date, by Hon. D. F. Simpson, Judge of District Court.
Crusade Against Ugliness, by Mr. J. Horace McFarland.
The Civic Spirit in Practice, by Mayor J. C. Haynes.
Boosting Your Home City, by Mr. F. W. A. Vesper.

The foregoing are but a few striking titles selected from a remarkable program of work done for a city, work which has not been in vain.

After hearing some of the proverbial tall talk in Chicago one is apt to smile incredulously, and may be perhaps forgiven for doing so, when told in Minneapolis that "here are the largest flour and lumber mills in the world." Whatever doubt I possessed was dispelled after spending two hours inspecting the immense flour mills of the Washburn-Crosby Co.

Much as I should like to discuss Minneapolis at greater length space will not permit. I will close by quoting the concluding paragraph from an interesting pamphet entitled "Minneapolis after Fifty Years."

From the earliest days when Minneapolitans all knew each other by their first names, and stood shoulder to shoulder in fighting for the common good, there has come down to the present generation the priceless heritage of "the Minneapolis spirit." It is a spirit marked by aggressiveness for the common good, by a sinking of personal consideration in promoting the broader interests of the community; by an insistent and continuous demand for nothing short of the best, intellectually, morally and materially. . . .

This is the spirit which must carry a city far, the spirit which means something above and beyond mere dollars: that it is lacking in both American and English municipalities is a matter for regret.

Having devoted some little time to investigation and study of the refuse-disposal problem in such cities as I was able to visit I feel bound to say that the problem is undoubtedly of a more complex nature than is the case in England. Personally, it was my conviction that this must inevitably be so, having in mind the widely differing climatic conditions that obtain as between the East and the West and South. While it may be urged that one standard type of destructor will compass the average requirements within the British Isles, it is certain that various types will

be required to adequately meet the varied requirements of American municipalities.

At the same time there can be no doubt that the valuable experience gained by those responsible for the design of British destructors operating in many countries, should enable the British combustion engineer to fully meet the most exacting requirements. In actual practical experience—which in work of this kind counts for so much—he must undoubtedly occupy a far more advantageous position than anyone else.

While it is very doubtful indeed whether garbage in England is sufficiently rich to warrant its treatment by any reduction process, it is beyond all question in the United States that the unsavory medley termed garbage does warrant such treatment, and it would be idle to pretend or argue that there is any other process yet devised which will yield anything like the same revenue from garbage alone.

It is true that garbage reduction has had a checkered history and that complaints of nuisance have been very frequent, widespread and well-founded; this, however, has been due very largely to the unsatisfactory conditions under which contracts have been let, and the fact that the process has not been regarded as one demanding the service and experience of the skilled engineer. Further, many installations have been so located and operated as to conduce to nuisance, while the filthy condition of many of these works is too well known to call for any description.

In the more recent installations, such as that at Columbus, Ohio—a municipal undertaking—the engineer has at length come into his own, and this plant reflects the greatest credit upon Mr. Irwin S. Osborn and those concerned with him in the equipment of this interesting, successful and carefully designed works.

When discussing the question of refuse disposal with Commissioner Briggs, of Milwaukee, he gave it as his opinion that the future of garbage disposal in the larger cities of the United States would be in the main confined to reduction, but that the ideal arrangement undoubtedly is a combined undertaking comprising a reduction plant for the garbage and a destructor for the rubbish and ashes; the destructor being arranged to supply the steam for the operation of the reduction plant.

The writer is of opinion that interesting developments along such lines will be seen within the next few years in spite of all that may be said by those who advocate the burning of every class of waste, irrespective of local conditions.

Minneapolis was visited mainly to see what was being done in the cremation of garbage. While being much indebted to Dr. P. M. Hall, the well-known and energetic city health officer, for granting facilities for the inspection of the local incinerator, it was a grievous disappointment to an advocate of cremation. The only point that appealed in any way to me was that the works were maintained in a cleanly condition. To my mind the whole installation is a striking object lesson as to what may and will happen when the gulf between the medical man and the engineer is not realized. In order to appreciate the extent of this gulf, it is necessary that the layman or even the engineer who visits Minneapolis should also inspect the refuse disposal works at Milwaukee. The resident engineer and superintendent at these works, Mr. Samuel A. Greeley, will be heard of in the future in connection with refuse disposal in America. The Milwaukee works are well designed and operated. In spite of many difficulties Mr. Greeley has shown much resource and an unusual capacity.

Unfortunately at the present time, these works, in common with the destructor works at New Brighton, Staten Island, are unable to show such a low net operating cost as one would wish to see. This is entirely due to the fact that it has not yet been possible to utilize either the clinker or the steam. When a revenue is derived from these sources, the net cost per ton of refuse destroyed will be materially reduced. At the New Brighton works my friend, Mr. Fetherston, has done an immense amount of pioneer and experimental work, the results of which will be seen hereafter.

The most successful works in England are those centrally located, whereby the cartage cost is cut down to the minimum, and where the steam and clinker are fully utilized.

Those who are opposed to the adoption of destructors of British types in the United States observe that it will never be possible to dispose of the steam and clinker under such conditions as obtain in American municipalities. This remains to be seen. In this connection it is interesting to observe that fifteen years ago precisely the same opinion obtained in England, and this in spite of the fact that the first destructor had then been in use for about twenty years.

The proverbial conservatism which so long prevailed to the detriment of economic waste disposal in England, has no counterpart in America. When once it is realized that power is available, ways and means will be found for its utilization. Similarly, with the clinker residual, exhaustive experiments have already been made and in the near future the value of this material will be clearly demonstrated. The clinker which the writer inspected at Milwaukee and West New Brighton was a dense and vitreous material fairly comparable with that which finds a ready market in England, and for which there is an ever growing demand.

Such destructors of British types as are in operation in the United States at this time are in all essentials absolutely satisfactory. They have been tested before acceptance under conditions which may be said to be generally more exacting than are usually required in England. It may be observed that had the tests required in connection with many of the American crematories and incinerators now in operation been in any sense comparable with such tests as are carried out with destrustors either in England or America, very few of the furnaces of American design would be in use to-day. The conditions under which tests have been made and the character of the tests have had the effect of saddling many municipalities with furnaces which ought to have been rejected. The absurd, extravagant and impossible claims put forward in connection with American furnaces, afford entertaining reading but should fail to carry conviction to anyone possessing even a rudimentary knowledge of combustion, and yet after so-called trials these plants are accepted by municipal authorities; their acceptance implying that results which are absolutely impossible with any furnace have been shown.

In conclusion I should like to tender my sincere thanks to my many friends in New York, Buffalo, Chicago, Minneapolis, Milwaukee, Columbus, etc., who so kindly enabled me to see so many interesting features of a remarkable country of which I hope to see more.

Recent Investigations into the Nature of Cement at the Geophysical Laboratory, Carnegie Institution of Washington.[1]

By E. S. SHEPHERD.[2]

The chemical nature of cement clinker has been the subject of a great many experimental studies and of some mere guesses. This latter could scarcely be avoided since the fundamental theory, upon which such investigations must rest, had not been fully developed prior to 1900. Furthermore, the problem is relatively complex, the experimental difficulties great, and the experiments themselves very expensive.

For such a problem it is necessary to know not only how warm the material studied may have been, but how hot it is at any particular moment and what it is doing while hot. Post mortem methods do not serve the purpose. The chemist must therefore be able to examine these clinkers at temperatures up to about 2,100° C. He must be able to hold such temperatures constant for as long as may be necessary, and he must be able to repeat his experiments with identical conditions or to vary the conditions at will. The assistance of a mineralogist who can identify the extremely small crystals which result from such fusions is also necessary before undertaking the more complex mixtures he must have determined what compounds exist between the oxides taken two at a time, for example between CaO and SiO_2, CaO and Al_2O_3 and Al_2O_3 and SiO_2. He must know the exact temperatures at which the different combinations can exist and the characteristic properties of each must be so established that they can be promptly recognized when they occur in the more complex mixtures of three oxides.

It was for this reason that the early researches made at this laboratory were confined to the simple binary mixtures instead of beginning with the more complex mixtures which correspond to cement clinker. It is necessary to use the purest materials if the results are to be definite, and to make sure that the reactions which occur have had ample time to become complete, i. e., that equilibrium has been attained. Subsequently the results can be modified to meet the conditions found in commercial practice where various impurities become disturbing elements.

It will be remembered that in the first research (1906) on mixtures of pure lime and silica, only the mono- and dicalcic silicates could be located, and the much discussed tricalcic silicate was not found. As soon as alumina is added the tricalcic silcate appears as a compound of peculiar properties, and the reason for it being overlooked in the earlier research also becomes clear. With only lime and silica present this important compound is completely dissociated before the melting temperature is reached and does not recombine readily on subsequent cooling. In the presence of alumina, the fusion temperature is sufficiently reduced so that the compound can crystallize out of the melt. Together with dicalcic silicate it then forms the major portion of cement clinker. In the research on the lime-alumina series,[3] four combinations between lime and alumina were discovered, of which three, $3CaO.Al_2O_3$ — (tricalcic aluminate), $5CaO.3Al_2O_3$ and $CaO.Al_2O_3$ are possible constituents of cement clinker. Of these the $5CaO.3Al_2O_3$ is the most readily fusible. The tricalcic aluminate is also peculiar in that it dissociates before the temperature of *complete* fusion is reached, and this property has a very important bearing on the reactions taking place between these three oxides.

This research goes much further than any of the earlier attempts. It is well known, though often overlooked, that from such a ternary system the solid clinker will consist, except in very special and practically unrealizable cases, of at least three different compounds. In the earlier researches, it was assumed that pure clinker would consist of a mixture of two compounds, one lime-silicate and one lime-aluminate.

In order to represent graphically the relations existing between any three substances, it is customary to indicate the composition by means of an equilateral triangle, each side of which is divided into one hundred equal parts.[4]

In such a chart, each apex represents 100% of one of the oxides, while the opposite side represents 0% of that oxide. Thus, each side of the triangle will represent all possible mixtures of the two oxides which terminate that particular side. That is, each side corresponds to the biaxial diagram used to represent the properties of any two substances, where the temperature is being plotted along the ordinates, and the percentage composition of the mixtures along the base. In the triangular diagram the temperatures must be thought of as perpendicular to the surface of the triangle.

Thus, in Fig. 1, the base of the triangle indicates the relation existing between all possible mixtures of CaO and Al_2O_3. The formulas below the base show the compounds which can be formed from these two oxides, the percentage composition of the compounds being indicated by the small circles situated on the base line.

[1]Abstract of "Preliminary Report on the Ternary System $CaO—Al_2O_3—SiO_2$," by E. S. Shepherd and G. A. Rankine, with Optical Study by Fred E. Wright, to appear in the Journal of Industrial Chemistry, April, 1911.

[2]Geophysical Laboratory, Carnegie Institution of Washington, Washington, D. C.

[3]Binary Systems of Alumina with Silica, Lime and Magnesia, by E. S. Shepherd and G. A. Rankine; Optical Study, by F. E. Wright, American Journal of Science [illegible] 28, 293, 1909.

[4]See Thurston; Alloys, Brasses and Bronzes, pp. [illegible], 425. Bancroft; The Phase Rule, p. 147. Findlay; The Phase Rule and Its Applications, p. 227.

Similarly, the left side indicates the compounds existing between the oxides CaO and SiO_2; while the right side shows the analogous relations between Al_2O_3 and SiO_2.

It follows from the geometrical nature of such a diagram that any point within the triangle will indicate a mixture of 100% distributed among the three oxides in proportions determined by the distance of the point from the three sides of the triangle. Thus Z, the corner of the dotted rectangle in Fig. 1, indicates a composition of about CaO 65%, Al_2O_3 12% and SiO_2 20%.

It will be recalled that in the case of binary mixtures there is frequently an eutectic formed. At the eutectic composition, crystals of both substances separate out side by side and the whole mass freezes solid at a fixed temperature.

When, however, a third substance is added, this eutectic ceases to freeze solid at a fixed temperature. The two kinds of crystals separate side by side as before, but the temperature continues to fall instead of remaining constant. The mass does not freeze solid until the ternary eutectic is reached when the two crystals which first separated are joined by crystals of the third substance and the remaining liquid mass solidifies at a constant temperature. (Both here and in the subsequent treatment, we shall omit certain important special cases which would require too long a discussion. In the ternary diagram, this separation of two crystals side by side over a range of temperature follows a definite course and the line representing it is called a boundary curve. Along a boundary curve two kinds of crystals can exist with the molten portion of the charge. But on either side of such a boundary curve there is a field in which only one kind of crystal can coexist with the melt. This crystal is the one which first separates when the charge begins to freeze and is called the primary phase (or primary crystals). At the temperature of the corresponding boundary curve these primary crystals will be joined by the crystals from the other side of the boundary curve, and at the ternary eutectic by the tertiary crystals after which the charge freezes solid and consists of a *mixture* of all three kinds of crystals.

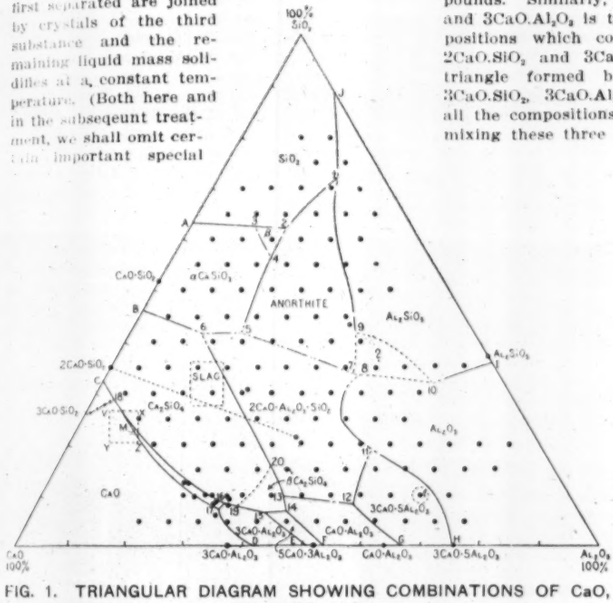

FIG. 1. TRIANGULAR DIAGRAM SHOWING COMBINATIONS OF CaO, SiO_2 AND Al_2O_3.

If we take that portion of the whole diagram which has to do with cement clinker (the lower left-hand corner), and plot it on a larger scale, we obtain Fig. 2. This portion of the diagram includes all mixtures containing from 45% of lime to pure lime at the apex marked 100% CaO. The base represents a part of the mixtures of lime and alumina, and the left side, part of the mixtures of lime and silica.

As before, the solid lines represent the boundary curves. Thus, the surface included within the lines joining 100% CaO, C, 18, 17 and D, gives the region in which free lime is the primary phase, i. e., the first to crystallize from the freezing melt.

The surface included between lines joining points 18, 17, 16 is the field where tricalcic silicate is primary phase. Neither points 18 nor 17 are eutectics, but are similar to point D in the lime alumina series. Within the field C, 18, 16, 15, 14, 13, 6, B, dicalcic silicate $2CaO.SiO_2$ is the primary phase.

Field D, 17, 16, 15, E is that for tricalcic aluminate.

E, 15, 14, F is the field for $5CaO.3Al_2O_3$.

To the right of F, 14, 13 is the field for $CaO.Al_2O_3$.

To the right of line 13 — 6, a compound similar to gehlenite, but of different composition, namely $2CaO.Al_2O_3.SiO_2$, is the primary phase.

Above 6—B there is a small field, not shown in this diagram, where a crystal very similar to okermanite occurs. The composition of this crystal is $3CaO.2SiO_2$.

The broken lines consisting of long dashes show the relative partition of the oxides among themselves. Thus, the line joining the compositions of $3CaO.SiO_2$ and $3CaO.Al_2O_3$ is the locus of all mixtures in which the ratio of the oxides would be that of mixtures of these two compounds. Similarly, the lime joining $2CaO.SiO_2$ and $3CaO.Al_2O_3$ is the locus of all possible compositions which could be obtained by mixing $2CaO.SiO_2$ and $3CaO.Al_2O_3$. Hence, within the triangle formed by joining the compositions $3CaO.SiO_2$, $3CaO.Al_2O_3$ and $2CaO.SiO_2$ we have all the compositions which could be obtained by mixing these three binary compounds.

By joining 100% CaO, $3CaO.SiO_2$ and $3CaO.Al_2O_3$, we obtain a triangle within which any composition chosen will always contain free lime, i. e., has more lime than enough to form $3CaO.SiO_2$ and $3CaO.Al_2O_3$, the two binary compounds richest in lime.

In a similar way, there is a triangle for mixtures of $3CaO.Al_2O_3$, $5CaO.3Al_2O_3$ and $2CaO.SiO_2$; and also a triangle, of which only one line is given, for mixtures which may consist of $2CaO.SiO_2$, $5CaO.3Al_2O_3$ and $CaO.Al_2O_3$.

It appears that most clinker compositions (within the rectangular V X Y Z) lie within the triangle which yields on freezing a clinker composed of $3CaO.SiO_2$, $2CaO.SiO_2$ and $3CaO.Al_2O_3$.

The dotted lines have no physical significance, but represent the progress of crystallization of certain mixtures.

Thus, when a mixture whose composition is indicated by P begins to freeze, the first crystals to separate (primary phase) are $2CaO.SiO_2$. The removal of solid $2CaO.SiO_2$ from the mixture changes the composition of the remaining liquid and the direction of this change is indicated by the dotted line passing through the point corresponding to the composition of $2CaO.SiO_2$ (the primary phase which is separating) and P, the initial composition of the charge. As more $2CaO.SiO_2$ separates, the composition of the molten portion continues to follow the dotted line to K. At K, the charge consists of two parts, crystals of $2CaO.SiO_2$ and a liquid or mother liquor of composition K, i. e., about CaO 58%, Al_2O_3 34%, SiO_2 8%. At this point the primary crystals ($2CaO.SiO_2$) are joined by the secondary crystals $3CaO.Al_2O_3$. As the temperature falls the composition of the molten part of the charge continues to change, following the boundary curve to point 15. Here crystals of $5CaO.3Al_2O_3$ appear and the charge freezes solid at a fixed temperature. The other crystallization curves can be followed in a similar way, but for further details the complete paper must be consulted.

The crystallization curve for M is not as simple as that for P, but the final result of the crystallization of this mixture is given under Type II. The crystallization curves passing through points Z, M, T, P, Q and R were selected merely to show that from these compositions all intimately related to cement clinker, five different products can be obtained, depending on the initial composition of the charge.

Cement clinker should therefore be divided into five possible types.

TYPE I.—Clinker of a composition given by Z (Fig. 2) will freeze solid at point 17 to a mixture of CaO, $3CaO.Al_2O_3$ and $3CaO.SiO_2$.

TYPE II.—A clinker of composition M will begin to freeze by separating out at CaO; at N, this separated lime combines to form $3CaO.SiO_2$ and is completely used up so that the next crystals to appear after the $3CaO.SiO_2$ will consist of $2CaO.SiO_2$. These two silicates will separate together until at point 16 they are joined by $3CaO.Al_2O_3$ and the clinker solidifies to a mixture of $3CaO.SiO_2$, $2CaO.SiO_2$ and $3CaO.Al_2O_3$. This is presumably the typical Portland cement clinker.

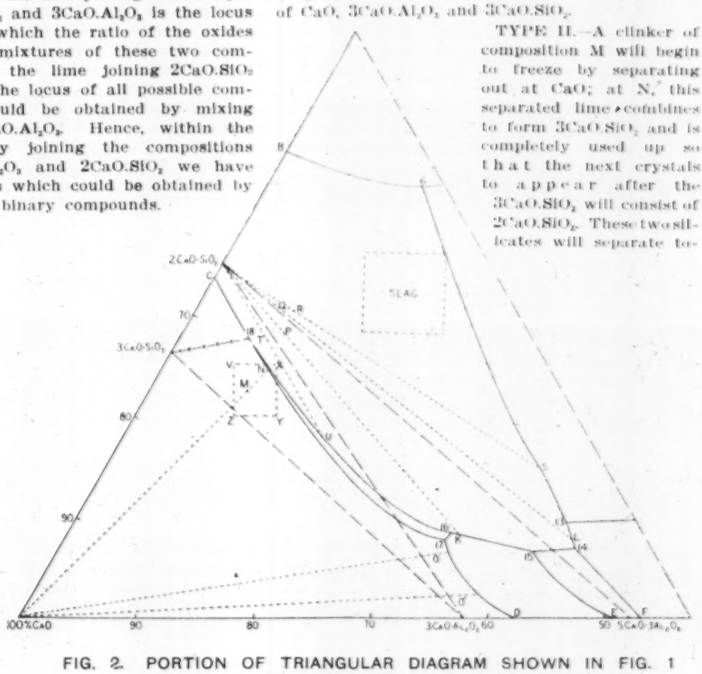

FIG. 2. PORTION OF TRIANGULAR DIAGRAM SHOWN IN FIG. 1 RELATING TO PORTLAND CEMENT CLINKER.

TYPE III.—A composition P, for example, solidifies to a mixture of $2CaO.SiO_2$, $3CaO.Al_2O_3$ and $5CaO.3Al_2O_3$.

TYPE IV.—Composition Q yields a mixture of $2CaO.SiO_2$, $CaO.Al_2O_3$, $5CaO.3Al_2O_3$.

TYPE V.—The final product of crystallization of a composition such as R is rendered slightly uncertain by the fact that point 13 should have a slightly different location for theoretical reasons. We must therefore regard this type as tentative, but at present such clinker should be made up of $2CaO.SiO_2$, $CaO.Al_2O_3$ and $2CaO.Al_2O_3.SiO_2$.

While this diagram deals with mixtures of pure CaO, Al_2O_3 and SiO_2 and cannot be applied without modification to commercial clinker, it is probable that the relations here described will not be altered in any fundamental particular by the impurities commonly found there. Of the effect of magnesia and iron oxide nothing definite is known. Neither seems to form solid solutions with $2CaO.SiO_2$, $3CaO.SiO_2$ or $3CaO.Al_2O_3$. Nor at the present writing, has any appreciable solid solution been discovered between CaO, Al_2O_3 and SiO_2 compounds.

It is now obvious, however, that cement clinker is much more sensitive to relatively small changes in composition than has been supposed heretofore. With the five types of clinker established it should now be possible to determine the

differences in cement forming qualities and to establish with much greater precision the limits of variation permissible in the best cement.

In passing it may be noted that there is a maximum about midway of the boundary curve 13—6, so that slag cements unless very rich in lime will crystallize to mixtures of $2CaO.SiO_2$, $2CaO.Al_2O_3SiO_2$ and $3CaO.2SIO_2$. If very rich in lime they might come below this determining maximum and thus be similar to Type V. above.

Micrometer Gagings of Structural Parts to Measure Dead-Load Stresses.

A new line of experimentation in the field of testing is being pursued by the Bureau of Standards in connection with its work on structural materials. It may be described most simply as the measurement of dead-load stresses in structures, but really has a broader scope. Essentially it consists of micrometer measurements of lengths between permanent marks made on a structural member. Its possibilities lie in (1) the simplicity and cheapness of the required apparatus, (2) the high sensitiveness of the method (on steel, the readings detect stress increments as small as 150 lbs. per sq. in.) and (3) the permanent character of the work, by virtue of which the condition of the structure at any time during its life can be referred back to the original unstrained condition.

Mr. J. E. Howard, while Testing Engineer at the Watertown (Mass.) Arsenal of the Ordnance Bureau, devised an instrument and a method for making extensometer measurements on structures in service. The conditions to be met in such work differ from those of laboratory tests, because it is usually not possible to keep the measuring device in position from beginning to end of the work. Ordinary extensometers therefore are seldom used, and their function of measuring the change of length between two gage-points must be carried out by measuring the gage length before and after loading. This, of course, means measuring to an accuracy far beyond anything required elsewhere in the field of physical testing. Mr. Howard not only solved this problem, but at the same time he designed gage-point marks of astonishingly simple character and thoroughly proof against injury in the handling of the part being tested. Due to this latter fact, it proved possible to make measurements on a part such as a bridge member before its erection in the bridge, i. e., in unstrained condition, and again after erection, i. e., under full dead-load stress, with good assurance that the marks had not changed in the interim. It is possible also to repeat the measurement at any subsequent time, the marks being practically indestructible, so that the distortion (and hence the stress) under any subsequent condition of loading may be determined. At the same time the simplicity of the marks permits of providing them in large number, and in almost any location, instead of restricting the measurement to one or two locations on a member.

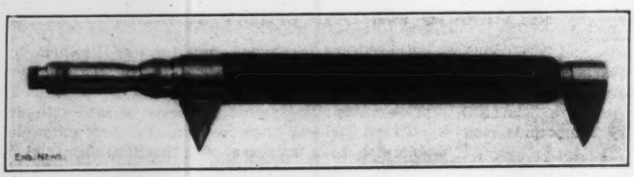

FIG. 1. VIEW OF TEN-INCH HOWARD STRAIN-GAGE.

(Micrometer head at Left end; reads to 0.0001-in. Barrel of gage has heat-insulating covering to reduce temperature disturbances from handling.)

The measuring instrument consists of a tubular bar about 20 ins. long, and a cylindrical bar fitting inside the tube and adapted to slide in it. The end of the latter bar projecting from the tube carries a short arm fixed at right angles to the bar. A similar arm is fixed to the tube at the opposite end. The ends of the two arms are shaped to slender tapered points, which fit into the recessed gage marks made on the piece to be measured. When the two points are set in the marks, their distance apart may be measured by a micrometer screw attached to an extension of the tube over the head of the internal bar. The micrometer reads to 0.0001-in. On the 20-in. length this corresponds to one part on 200,000.

A 10-in. gage of the same type is shown in Fig. 1. This instrument was used for strain measurements in the tests of Steubenville Bridge columns reported in our issue of March 16, 1911.

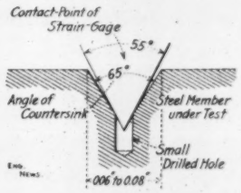

Fig. 2. Sketch of Gage-Mark Used for Strain-Gage Tests of Steel Structural Members.

The 20-in. length is preferred where it can be used. Fig. 3 shows this size, during measurements on a brick track pavement.

The gage marks are made by drilling a hole 1/64-in. in diameter, about ⅛-in. deep, and countersinking over it with a 65° countersink to an outer diameter of about 1/16-in. A ½-in. circle scribed around the hole makes it easier to find. The conical contact-points of the measuring instrument have a taper angle of about 55°, and when inserted in the hole they bear only on the intersection of the cylindrical and conical parts of the hole (Fig. 2). This intersection edge is well protected by its position against external damage, and at the same time furnishes a contact not affected by deposits of dust and dirt in the hole. After a measurement has been made at a pair of marks, each mark is daubed over with a bit of putty, which seals the hole and keeps out rust as well as dirt.

After the instrument and the form of gage-mark were devised, tests were made at Watertown, and also in a building being constructed in Boston, to learn what degree of accuracy and uniformity could be obtained in practical use, and more particularly to learn whether the conditions of field work were such that readings made at different times but under the same load conditions would check closely. The instrument itself soon proved its ability to furnish readings as close as 0.0001-in., and to maintain this sensitiveness without impairment. Readings made at different times, with temperature conditions closely constant, checked satisfactorily, being either identical or not more than one or two ten-thousandths inch apart.

Temperature conditions later were found to be disturbing. The expansion of steel on a length of 20 ins. is 0.00013-in. per degree Fahrenheit; thus if the member being tested and the instrument differ only 1° in temperature, the reading will be more than one unit in error. Differences of several degrees, perhaps in opposite directions in two successive measurements, will produce discrepancies so great as to make the results unreliable, and must be guarded against.

The following procedure was arranged to get around the difficulty. A steel comparison bar, 20+ ins. long, with gage marks drilled in its upper face 20 ins. apart, calibrated so as to be accurately reproducible, is added to the field equipment. While measurements are in progress, the bar is kept in contact with the member being measured, or near it under such exposure as to subject it to the same temperature conditions as the test member. Each measurement of the test member is immediately followed by a comparison measurement on the standard bar, and the difference added to the known length of the standard bar is taken as the true measured length. The details of the procedure are modified to suit the location and other conditions of the work.

BEAVER BRIDGE TESTS.—The first important trial of the method was on the new Beaver cantilever bridge of the Pittsburgh & Lake Erie R. R. The object here was to secure measurements of the actual dead-load stresses in the main members, by establishing marks on the members before erection and taking measurements first in this unstrained condition and after completed erection. The subject of stress distribution in large bridges, which is known to be involved in many uncertainties, has heretofore been studied by extensometer tests under live-loads, but the results of such tests, however valuable, have always suffered because no means was at hand to measure the existing dead-load stress. The importance of the latter increases very greatly when the dead-load stresses exceed the live-load stresses, as in very large bridges, and in buildings, etc. Mr. Howard's method for the first time affords a means for measuring total stresses at any time during the life of a structure, provided only that marks have been made and gaged before erection. The officials of the New York Central Lines recognized this value of the proposed experiments on the Beaver Bridge, and gave permission for the work and lent their cooperation.

While the work was in its early stages, Congress transferred the work of general testing from Watertown Arsenal to the Bureau of Standards, and Mr. Howard went to Washington. Director S. W. Stratton of the Bureau appreciated the technical and industrial value of the work which Mr. Howard had started, and authorized its continuance as Bureau work. An account of the Beaver Bridge tests and their results is to be published shortly in a Bulletin of the Bureau of Standards.

Briefly, the results of the work were to show that temperature disturbances create serious difficulties in the case of bridges, but can be largely avoided by early morning measurements; that consistent and close determinations of dead-load stress, as well as of stresses under stationary live-load, can be obtained; that the observed dead-load stresses in the Beaver Bridge agreed well with the computed stresses; and that secondary stresses of material amount were found near joints.

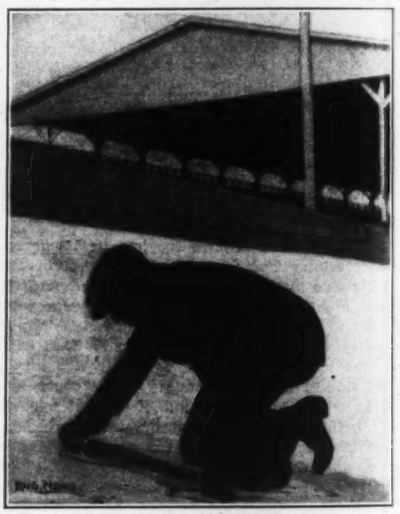

Fig. 3. Making Strain-Gage Measurements of Temperature Expansion on Brick Track Pavement, Indianapolis, Ind.

(A 20-in. strain-gage is being used. With a reading to 0.0001-in., this gives a sensibility of 1:200,000.)

BANKERS TRUST BLDG. TESTS.—Tests are now in progress under Mr. Howard's direction in the Bankers Trust Bldg., a 30-story office building being erected on the site of the razed Gillender Bldg., Nassau and Wall Sts., New York City. The architects, Trowbridge & Livingston, are affording the necessary facilities for the work. This building when completed will not only be one of the highest in New York City but due to the use of trusses to give wide floor

are at certain levels some of the columns have a remarkably heavy section. The tests include heavy as well as ordinary columns; later they are to be extended to the trusses mentioned.

The test conditions are far more favorable in a building than on a bridge. The effects of direct absorption of sun's heat are eliminated because the work is under cover, and for the same reason the total range of temperature variations is reduced. The procedure of measurement with use of the comparison standard bar before becomes highly precise, and it has proved possible to obtain readings which regularly check within less than 0.0002-in., that is to say within a stress range of 300 lbs. per sq. in. It follows that the full series of tests will give quite definite and accurate information as to the stresses in the columns under test.

These tests of dead-load stress are obviously more important in buildings than in bridges, because nearly all of the load is fixed load. The marks being permanent, and provision for making them accessible in the completed building being relatively simple, observations can be taken at any time in the future for direct comparison with the initial measurements. In other words, it will be possible at any time during the life of the building to measure not merely a stress increment in a column due to changed load, but the total compression produced since the column was first set in place.

OTHER TESTS.—The Bureau of Standards has also looked to the application of this method to other fields of stress investigation. Two of these have come to our knowledge, and they throw an interesting light on the possibilities of the method.

At Indianapolis, Ind., a circular roadbed paved with brick has been made the subject of tests to determine what stresses arise in the pavement from temperature variation. Marks were provided for measurements longitudinally and transversely of the pavement, and it is intended to observe them in different seasons (see Fig. 3). Temperature expansion in the transverse direction is largely unhindered, but that in the longitudinal direction is suppressed; the difference of the readings ought to give a basis for estimating the compressive stress in the pavement due to expansion. The marks in this case are made in brass plugs set into the brick.

Stress distribution in boiler shells has been studied by measurements on a boiler during hydraulic pressure test, at Providence, R. I. The purpose in this case was to gain information as to the distribution of stresses, particularly near the ends of the shell. The current methods of design and analysis do not take account directly of the interaction of shell and head, or of possible non-uniformity of stress distribution due to various mechanical causes.

Tests of a Boiler Plant Using Lignite Fuel.

The U. S. Reclamation Service in connection with its Williston Irrigation Project has erected a large pumping plant at Williston, North Dakota, and has installed there six boilers, with furnaces designed to burn a brown lignite which is mined on adjacent government land. Certain recent tests, made in this plant and showing success with this fuel, are considered important by the Mining Bureau on account of the extensive deposits of lignite in the Northwest and of the distance of this region from other coal fields.

The six boilers are a water-tube type of the design shown in Fig. 1. The boiler proper is of a standard design, and interest largely centers in the furnace and its accessories. This furnace is a semi-gas producer type, outwardly resembling a Dutch oven. The prominent features in its construction are the deep-set grate, the contraction of the space between the bridge wall and the end of the prolonged fire-brick arch. The grate is 21 ins. below the lower edge of the fire door, so as to enable the firemen to carry a thick fuel bed and still see its condition at the top. A side furnace door, shown in Fig. 1, is intended for removing clinkers and is only 7 ins. above the grate.

The solid fuel is designed to be burned, much as in a gas producer. It burns, with incomplete combustion on the grate and the gas passes out under the arch into a combustion chamber. The air, necessary for complete combustion, is added through openings in the bridge wall. This air is forced through a duct leading from pre-heating coils in the upper back part of the boiler proper, the air being heated to from 200° to 300° F. before passing to the holes in the fire-brick wall. Owing to the location and direction of these openings, the air is projected in jets into the comparatively slow-moving body of combustibe gas, so that a fairly good mixture of gas and air is secured. Openings, for the admission of air, are also seen in the roof of the Dutch oven, but this air can consist only of leakage through the outside wall into the air space which entirely surrounds the fire-brick lining, as shown in Fig. 1. When the rate of combustion exceeds 25 lbs. of coal per sq. ft. of grate surface, the flames of the burning gas are stated to extend out into the space above the fire-brick arch where the gases make their first upward sweep.

The furnaces has a rocking grate, made up of two rows of grate bars, connected to two shaking levers in such a way that, by shaking one lever, alternate bars in the row are rocked. All the grate bars are supported by a 2-in. pipe, through which cold air circulates, keeping the grate bars and the ash immediately above them cool to reduce clinkering and adhesion. Cold air from the fan is brought through a special duct to the pipe "F" in the ashpit; it flows through the grate-supporting pipes into the pipe "G," through the lower tunnel in the bridge wall and into the pit "T," from which it is blown into the ashpit by steam jet blowers. The pressure in the ashpit varies from 1 to 2 ins. of water, while the pressure necessary for circulating cold air through the supporting pipes is only from ½ to 1 in. of water, so that the cooling air cannot be discharged from the circulating pipes directly into the ashpit.

The boilers are operated under balanced draft, that is, the ashpit is kept at a pressure higher than the atmosphere while the flue-gas up-take is under a pressure a little below the atmosphere, so that the furnace itself is about at atmospheric pressure and the fire doors may be opened for firing without allowing outside air to enter.

A coil in the boiler front is used for superheating the steam used by the Argand jet blowers, and ordinarily the steam used in these two

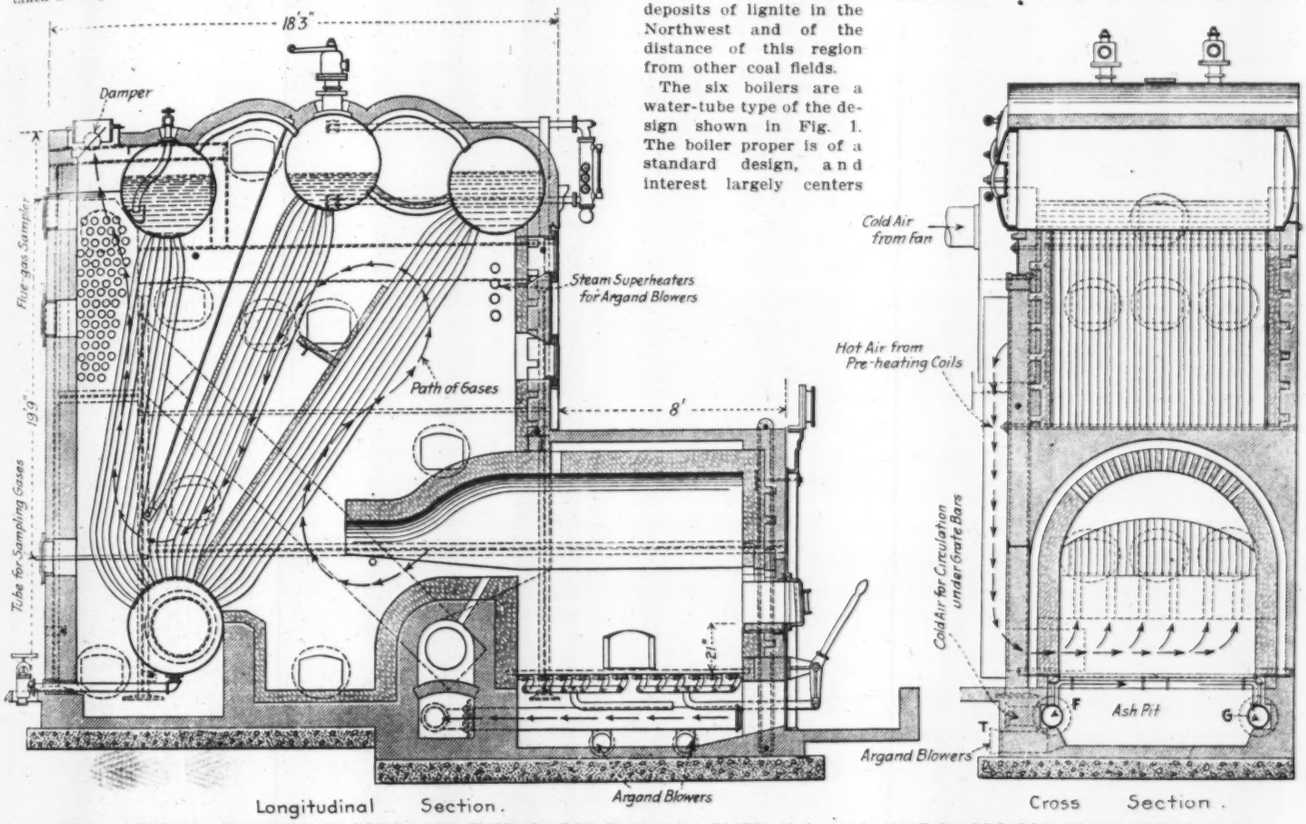

FIG. 1. VERTICAL SECTIONS OF BOILER AND FURNACE FOR BURNING LIGNITE; U. S. RECLAMATION PROJECT AT WILLISTON, N. D.

*Abstract of a report, "North Dakota Lignite As a Fuel for Power-Plant Boilers," published as Bulletin No. 2 of the U. S. Bureau of Mines, Washington, D. C.

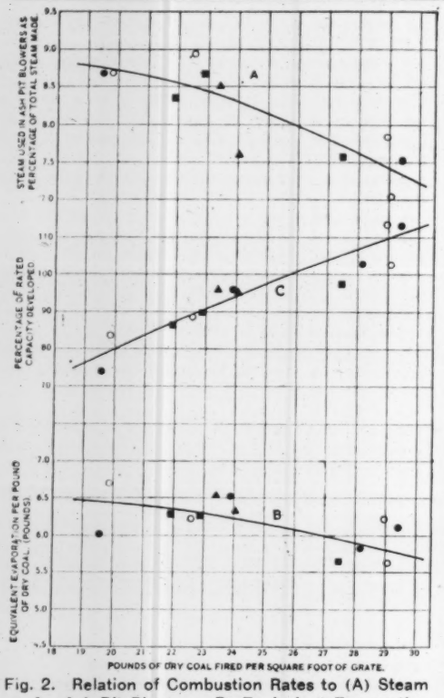
STEAM USED IN ASH-PIT BLOWERS AS PERCENTAGE OF TOTAL STEAM MADE
PERCENTAGE OF RATED CAPACITY DEVELOPED
EQUIVALENT EVAPORATION PER POUND OF DRY COAL. (POUNDS)
A
B
C
POUNDS OF DRY COAL FIRED PER SQUARE FOOT OF GRATE.

Fig. 2. Relation of Combustion Rates to (A) Steam for Ash-Pit Blowers, (B) Equivalent Evaporation per Pound of Dry Coal, and (C) Percentage of Rated Capacity Developed.

blowers is taken from the same boiler with which the blowers are working.

The test made by the Survey in this boiler plant was primarily to show that the lignite coals of North Dakota are suitable for making steam on a large scale, but there were the secondary objects of determining the effect of the size and weathering of coal on economy and to determine whether or not there is any gain in superheating the steam used in the Argand blowers.

The fuel contained about 40% moisture and 7 to 8% of ash. In most of the tests the coal was burned soon after being mined. It was delivered in run-of-mine form to the power plant, where it was crushed either by power or by hand.

Methods of Conducting Tests.*

By D. T. RANDALL‡ and HENRY KREISINGER.†

The standard method of starting and closing tests was out of the question, so that a modification of the "alternate" method was used. The fuel bed was considered to be in its best condition when 18 to 22 ins. thick. When a new fire was started with wood it took several hours to build up the bed and fire to a good running condition. Generally, in starting, a fire was made with wood at about 4 a. m. and the fuel bed was gradually built up until about 9 a. m., when it was 16 to 1 8ins. thick. At this time the furnace was thoroughly heated and in condition for starting the test. The grates were well shaken and all ash removed from the ashpit. At the time of starting and of closing each test, the height of the fuel bed was estimated as accurately as possible by sighting over the bottom of the fire door opening.

At the end of the second test the fuel bed was burned down to the same height as at the start, and it was thought that only a negligible amount of clinker would be found in the bed. However, after closing the test and burning the fuel bed down still farther, several hundred pounds of clinkers were found on the grate. Therefore in all subsequent tests corrections were made for clinkers by closing the test with the fuel bed 3 or 4 ins. higher than when the test was started. This method was necessary because the clinkers could not be pulled out during the test on account of the grate being so far below the firing door. Care was taken also to

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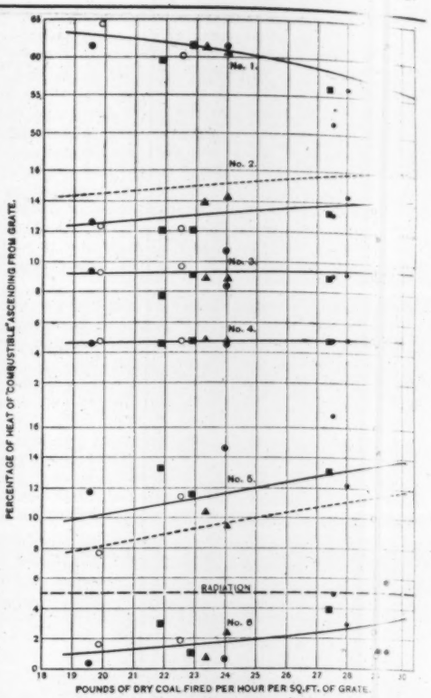


Fig. 3. Combustion Rate Relations.

(To: (1) Heat absorbed by boiler; (2) heat lost in dry chimney gases; (3) in moisture in coal; (4) in moisture formed by the burning of hydrogen of coal; (5) heat unaccounted for; (6) heat lost in unburned CO in the flue gases.)

SUMMARY OF OBSERVED DATA AND CALCULATED ITEMS, STEAMING TESTS OF NORTH DAKOTA LIGNITE MADE BY U. S. GEOLOGICAL SURVEY, OCT. 8-29, 1908.

Test No.	Hours' duration.	Condition of fuel.	Total lbs. fuel. As fired	Dry.	Ash and refuse.	Fired per hour.	Per cent. refuse in dry coal.	Proximate analysis, per cent. Fixed carbon.	Volatile matter.	Moisture.	Ash.	Sulphur in moist coal.	Composition of refuse. Carbon.	Earthy matter.	Clinker.	B.T.U. per lb coal.
1	3.18	Fresh[1]	6,350	.....	258	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	13.77	Fresh[1]	30,729	17,897	1,540	1,300	8.60	28.01	22.93	41.76	7.30	0.42	15.10	84.90	28.3	10,121
3	10.47	Fresh[1]	29,000	16,527	1,558	1,579	9.43	26.01	23 72	43.01	7.26	.60	22.85	77.15	47.0	10,098
4	14.75	Fresh[1]	27,998	15,606	2,198	1,038	14.08	24.00	24 51	44.26	7.23	.79	30.60	69.40	39.4	10,075
5	14.25	Fresh[2]	28,000	16,895	1,170	1,186	6.93	27.56	26.46	39.66	6 32	.63	22.75	77.25	20.6	10,397
6	11.13	Fresh[2]	28,340	16,536	1,103	1,486	6.67	25.75	24.78	41 65	7.82	1.29	37.24	62.76	43.1	10,026
7	12.70	Fresh[2]	27,101	15,705	781	1,237	4.97	25.82	24.10	42.05	8 03	1.71	12.98	87.02	60.3	9,936
8	10.00	Fresh[1]	28,000	15,725	1,086	1,573	12.63	24.86	24.08	43 84	7.22	1.09	23.45	76.55	47.4	10,116
9	12.95	Fresh[1]	28,500	15,837	1,665	1,223	10.51	24.65	24.22	44.43	6.70	1.20	16.79	83.21	46.5	10,190
10	14.67	Fresh[1]	28,000	15,764	1,586	1,075	10.06	25.28	24.31	43.70	6.71	1.01	13.04	86.96	49.7	10,222
11	10.03	Fresh[1]	28,000	15,994	1,997	1,595	12.49	24.96	24.22	42.88	7 94	1.53	36.64	63.36	34.9	10,049
12	11.00	Fresh[1]	30,000	17,271	1,084	1,570	6.27	26.17	24.80	42 43	6 60	1.22	11.68	88.32	49.8	10,278
13	13.42	Weathered[3]	30,000	17,460	1,309	1,302	7.49	28.22	23.13	41.77	6 88	.96	18.39	81.61	55.8	10,278
14	12.73	Weathered[4]	27,997	16,129	1,075	1,267	6.67	27.94	23.27	42.39	6.40	.84	5.25	94.75	63.5	10,330
15	12.12	Fresh[1]	31,672	18,167	2,391	1,490	13.16	27.41	23.42	42.64	6.53	1.18	21.56	78.44	38.8	10,271
15A	8.13	Fresh[1]	21,659	12,424	1,635	1,528	13.16	27.41	23.42	42 64	6.53	1.18	21.56	78.44	38.8	10,271

Test No.	Average thickness fuel bed, ins.	Av. Min. between firings.	Analysis dry chimney gases, per cent.[5] CO_2	O_2	CO	N_2	Pressure steam gage	Draft, ins. water. Below atmosphere. Stack.	Furnace.	Above atmosphere. Ash pit.	Bridge wall.	Average temperatures, F°. Fire. room.	Air to bridge wall.	Feed water.	Flue gas.	Furnace.
1	9-10	5.6	10.43	7.34	1.49	80.74	141.4	0.61	0.12	0 66	....	85	....	55	442	1.791
2	19	4.6	10.04	9.04	.10	80.82	134.6	.15	.75	.90	0 17	75	271	54	373	2.181
3	22	3.3	11.11	7.34	.19	81.36	131.9	.23	.10	1.40	.16	83	279	53	457	2.171
4	18-20	5.0	9.79	9.27	.05	80.89	133.1	.13	.11	1.42	.17	84	240	54	436	2.014
5	17	4.9	10 83	7.99	.58	80.60	133.9	.18	.14	1.55	.13	88	251	56	474	2.145
6	22	3.6	11.18	7.42	.79	80.61	130.7	.24	.15	1.78	.32	72	246	60	519	2.169
7	22-24	4.2	12 40	6.37	.23	81.00	134.8	.11	.09	1.32	.42	66	217	57	494	2.122
8	18-20	3.5	12.23	6.45	.19	81.13	135.1	.24	.13	.97	.27	68	241	51	521	2.086
9	22	4.2	11.49	7.60	.36	80.55	131.0	.21	.16	1.67	.33	67	218	55	472	2.160
10	20	5.0	11.06	8.20	.32	80.42	131.6	.16	.12	1.37	.38	68	207	43	462	2.148
11	20	3.1	10 92	8.26	.23	80.59	135.2	.41	.21	1.74	.36	69	242	39	570	2.073
12	18-20	3.2	12.14	6.46	.52	80.88	135.0	.32	.18	1.83	.73	65	210	48	549	2.165
13	22	3.9	10.40	8.74	.43	80.43	131.4	.30	.20	1.78	.46	65	197	54	500	2.115
14	22	4.1	11.50	7.83	.12	80.55	131.3	.27	.17	1.95	.54	75	210	48	528	2.161
15	18-20	4.8	11.44	7.03	1.03	80.50	133.5	.31	.17	2.35	.43	66	223	41	526	2.129
15A	18-20	4.8	11.54	7.12	.58	80.76	133.2	.38	.20	2 27	....	67	....	38	555	2.156

Test No.	Eq. water from and at 212° F. Per hour.	Per lb. fuel fired.	Evaporation factor.	Per cent. moisture in steam.	Per cent. Rated HP. developed.	Efficiency.[6] Boiler and furnace alone.	Over all.	Heat balance, per cent. Lost in dry flue gas.	Loss due to moisture. In fuel.	From H_2 in coal.	Loss: Incomplete combustion carbon.	Loss: Escaping hydrocarbon, radiation, and unaccounted.	Boiler for Argand blowers. Hours used.	Lbs. steam per hr.	Per cent heat in form. steam
1	6,990	3.50	1.2105	0.35	81.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	8,234	3.69	1.2104	.75	95.5	61.35	.....	10.47	8.36	4.56	0.60	14.66	.....	.....	.....
3	9,494	3.43	1.2110	.60	110.1	58.99	.....	11.78	9.06	4.67	1.01	14.49	.....	.....	.....
4	6,372	3.36	1.2102	.68	73.9	61.23	52.59	12.62	9.47	4.60	.30	11.78	14.60	469	5.11
5	7,445	3.79	1.2082	.94	86.3	59.38	53.59	11.99	7.68	4.65	3.05	13.25	8.37	503	4.71
6	8,397	3.30	1.2036	1.49	97.4	56.05	49.98	13 24	8.02	4 80	3.95	13.03	9.55	575	4.44
7	7,757	3.63	1.2074	.74	90 0	61.46	55.32	12 05	9.10	4.78	1.09	11.52	12.13	574	5.43
8	8,856	3.16	1.2136	.69	102.4	55.56	49.81	13.00	9.71	4.82	.91	16.00	8.33	524	3.84
9	7,614	3.46	1.2088	.93	88.3	60.17	53.70	12 14	9.69	4.74	1.82	11.44	9.87	573	5.31
10	7,200	3.77	1.2213	1.01	83.5	64.24	57.88	12.30	9.33	4.71	1.68	7.74	13.47	507	5.42
11	9,725	3.48	1.2261	1.05	112.8	62.52	54.46	15.90	9.66	4.91	1.23	5.78	9.12	639	4.71
12	9,773	3.58	1.2167	.79	113.3	59.10	54.04	13 61	9.16	4.87	2.46	10.80	10.53	661	4.85
13	8,210	3.67	1.2099	1.53	95.2	60.47	54.36	14.23	8.76	4.79	2.38	9.37	9.30	591	5.19
14	8,281	3.77	1.2161	.80	96.0	61.33	55.82	13.88	8.93	4 82	.62	10.42	12.22	594	5.33
15	7,911	3.03	1.2238	1.36	91.7	51.24	.....	13.10	9.14	4.84	4.94	16.74	.....	.....	.....
15A	8,908	3.34	1.2268	1.21	103.3	56.66	.....	14.30	9.23	4.80	2.87	12.05	.....	.....	.....

[1]Crushed by crusher, 20 to 30% slack.
[2]Hand crushed.
[3]Exposed to wind and sun 48 hours.
[4]Exposed to wind and rain 24 hours.
[5]Hydrogen and hydrocarbons not determined.
[6]Figured from chemical analyses of ash and coal.

have the height of water and steam pressure in the boiler as nearly as possible the same at closing as at start. The process of pulling out the clinkers at the close of the test was very difficult and took from one to two hours. Even then, only the larger pieces could be pulled. It is estimated that only from about one-half to two-thirds of the total weight of clinkers originally were removed, weighed and charged to the test. The method of obtaining the weight of ashes and clinkers was therefore very crude, but it was considered the best that could be done under the circumstances.

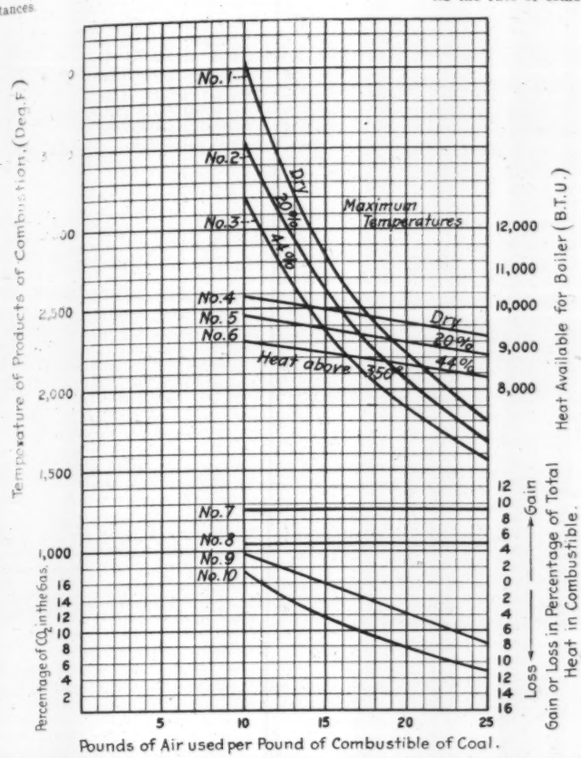


FIG. 4. CURVES SHOWING EFFECT OF MOISTURE IN LIGNITE FUEL.

(Relation of temperature of the products of combustion to weight of air per pound of combustible; (1) for lignite chemically dry; (2) for lignite containing 20% moisture; (3) for lignite containing 44% moisture. Heat available for boiler in burning 1 lb. of combustible of lignite; (4) with moisture previously driven off; (5) with moisture reduced to 20%; (6) with 44% moisture. Curve 7 shows gain of conditions of Curve 4 over conditions of Curve 6. Curve 8 shows gain of condition of Curve 5 over conditions of Curve 6. Curve 9 shows gain or loss when less or more than 15 lbs. of air is used per pound of combustible. Curve 10 shows percentage of CO_2 in the flue gases under varying air supply.

Coal was weighed in a wooden box on a platform scale holding about 500 lbs. One side of the box was removed for convenience in shoveling, and each time the box was filled a sample of about a shovelful was collected. Feed water was measured in a specially constructed, cylindrical tank, holding about 1,293 lbs. at 60° F. During the test all pipe lines, except the injector, were disconnected from the boiler, so that it was impossible for any water to get into the boiler except what was measured and fed in by the injector, or for any water to get out except as steam from the steam main. The steam used by the jet (Argand) blowers in the ash pit was furnished by a separately operated locomotive boiler. The water fed into this boiler was weighed and charged against the blowers. In each test the rates of combustion were kept as nearly constant as possible by changing drafts. Samples of flue gas were collected and analyzed for CO_2, O_2, and CO with the Orsat apparatus. Temperature measurements were taken at regular 20-min. intervals. The draft pressures were measured on all tests by manometers at the ash pit, over the fuel bed, in the up-take, and in the pre-heated air duct.

In all, 15 tests were made. In Tests Nos. 8, 9, 10 and 12, saturated steam was used for the Argand blowers, and for all other tests, superheated steam. In Tests Nos. 5, 6 and 7, coal crushed by hand was used; in all other tests it was reduced by crusher. Coal in Test No. 13 was exposed to wind and sun for 48 hrs.; that in Test 14 was exposed for 24 hrs. The visible smoke during all the tests was very light and appeared to be largely water vapor. The summary of observed data and calculated results are shown in the accompanying tables. Figs. 2 and 3 graphically present the relation between the data taken and the calculated results. Each symbol on the chart represents one test. The hollow circles show tests made with saturated steam in the ashpit jet blowers. Solid circles show tests with superheated steam for these blowers. Tests with hand-crushed coal are shown by solid squares, and coal on all other tests was reduced by a crusher. The two tests shown by triangles were made with weathered coal.

Fig. 2 shows the relation of the rates of combustion to (A) steam used by ashpit blowers, (B) equivalent evaporation per lb. of dry lignite, and (C) percentage of rated capacity developed. Although the results do not follow closely along the single lines in each case, general indication may be seen.

As the rate of combustion increased from 19 to 29 lbs. per sq. ft. of grate per hr., (dry lignite, the equivalent evaporation fell from 6.4 to 5.8 lbs. of steam. This was caused to some extent by the less perfect absorption of heat by the boilers, but largely from the less perfect combustion of the gas from the fuel. Hand-crushed coal did not give better results than machine-crushed, and the use of superheated steam in the ashpit blowers did not improve the evaporation. The tests made with weathered coal showed a small but indecisive improvement. Examination of the chemical composition of the weathered coal showed that the excessive moisture had been reduced but little and that more benefit could be gained by longer weathering.

Curve A, of Fig. 24, showing the relation of the rate of combustion on steam consumption of the ashpit blowers, indicates that, as the rate of combustion increased from 19 to 29 lbs., this steam consumption decreased from 8.6 to 7% of total steam generated. The drop in this steam consumption is perhaps contrary to what might be ordinarily expected, as in fan blowers the steam consumed would increase approximately as the square of the rate of combustion. The decrease in consumption of the steam-jet blowers was undoubtedly due to an increased efficiency at higher speeds of injected air, attained by increasing the steam pressure immediately back of the small orifices of the blower. The amount of steam, however, used during a given period in these blowers was too high and, considering the already great abundance of moisture in the lignite, steam was not needed in the ashpit. This has suggested the possibility that the same results could be accomplished with a less expenditure of steam by the use of a fan blower. Curve A also shows that the consumption of steam by the jet blower was about the same whether saturated or superheated.

Fig. 3 shows the variation in the distribution of heat, each item being expressed in percentage of total heat of combustible ascending from the grate. The amount of combustible is equal to the total combustible of coal as fired, minus the amount of combustible in the refuse. The curve for heat absorbed by boiler shows that in general this efficiency drops from about 63 to 57% as the rate of combustion increases from 19 to 29 lbs. This is due mostly to incomplete combustion of gases in the combustion chamber, a statement which is supported by curves of heat unaccounted for and heat lost in unburned CO. The indication is that as the rate of combustion increases from 19 to 29 lbs., the CO lost increases from 1 to 3%. Other combustible gases are probably escaping unburned, together with small quantities of tar vapors, and perhaps solid carbon in the form of fine soot. The added heat lost in dry chimney gases is due to a less complete absorption of their heat, with increase of their temperature, and can be charged directly to the boiler proper. On account of radiation from the thermometers used, the recorded flue-gas temperature was probably 50° lower than the actual. If this was the variation, the heat loss in dry-chimney gases should be 2% higher and the unaccounted loss should be 2% less. The dotted lines in Fig. 3 show such positions.

The heat loss in moisture formed by burning the hydrogen in the coal has been plotted more to complete the graphical heat balance than to show any relation to other items. This loss was about the same for all tests and for all rates of combustion.

It is shown in Fig. 3 that the heat loss in CO increased 2% during the range of experiments and the unaccounted loss rose 3½%. It is probable that this increase was due to unconsumed combustible gases, tar vapors and perhaps soot. Assuming that the radiation loss was 5% and constant for the range of heats, by subtracting this from the unaccounted loss the remainder represents the loss due to unconsumed hydrogen and combustibles. Here this remainder is 3% at the lowest rate of fuel combustion and 6.5% at the highest. The increase is about the same as shown for the CO loss. Steaming tests made by the U. S. Geological Survey with other coals have shown this same relation between the CO and the variable part of the unaccounted losses.

In Fig. 4 are illustrations of the results of Test No. 4, in burning coal with varying supplies of air. The lignite used contained 44.26% of moisture. Calculations were made on the basis of one pound of combustible, the moisture formed by burning hydrogen being added to the moisture in the coal. This specific heat of water was taken as 1, the specific heat of steam as 0.48 and constant at all temperatures, the latent heat of steam as 0.965, the specific heat of flue gases as 0.24 and constant at all temperatures. The thermal value of 1 lb. of coal, by calorimeter, was 11,567. Calculations were repeated for coal with 20% moisture and for coal chemically dry and these calculations are plotted in Fig. 4. It is shown that, theoretically, maximum temperatures could be obtained for each air supply and that the temperatures rise rapidly as the air supply is reduced. In actual practice the rise would not be so rapid since the combustion would be less complete. The gains in heat available for the boiler, as the moisture is reduced, are shown by Curves 7 and 8 in Fig. 4; by driving off 24% of the moisture the gain is 5%, and by removing all of the moisture before burning the gain is 9.5%. Curve 9 shows that with reduction of air supply nearly to the theoretical minimum the gain in available heat would be 3.5%, theoretically. Practically, it is not believed that there would be any gain by reducing the air supply below 15 lbs. per lb. of combustible.

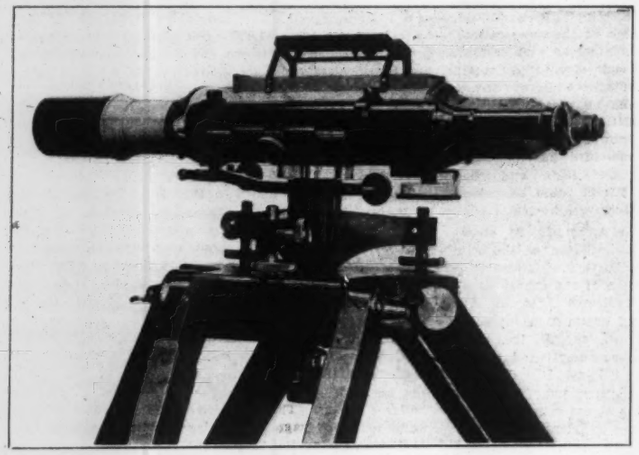
CONCLUSIONS.—The combination of boiler and furnace used, gives good results with this fuel. Steam can be made with the utilization of up to 58% of the heat in the coal and with no difficulty in developing full rated boiler capacity. The results compare favorably with results in an average boiler plant using good bituminous coal, considering the heat in the fuel which can be made available to the boilers. There is little advantage in hand crushing of the fuel over power crushing. Weathering of the lignite to reduce its moisture content seems to improve the economy. The steam-jet blower is inefficient and no gain results in the use of superheated steam for it; equally good results with a considerable saving in steam could probably be obtained by the substitution of a fan. The ash of this fuel fused at a comparatively low temperature so that clinker was easily formed in the fuel bed. In selecting this type of furnace, it was hoped that the solid combustible could be gasified at a low fuel-bed temperature so as not to fuse the ash, but, even at the moderate temperatures secured, fusing occurred. The clinker formed at the walls and grew out toward the center until the whole grate was covered. Shaking helped but little since the pieces of clinker are large enough to span two or three grate bars and merely ride on the top ones during shaking. Apparently the best remedy would be to provide doors, in the furnace front, low enough so that the clinker could be removed with a hook or hoe and without keeping the boiler out of service for more than 15 or 20 minutes at intervals of 12 to 18 hours. Side doors are unhandy because of the small space available for handling fire tools.

The semi-gas producer furnace is rather delicate in operation; sometimes the least change of air supply through the bridge wall of the air pressure in the ashpit or of the condition of the fuel bed, may result in high CO in the flue gases, indicating incomplete combustion. On a dry day, this may be detected by carefully observing the brownish color of the smoke from the stack but, on a damp, cloudy day, the excessive moisture in this particular kind of fuel condenses at the top of the stack and forms a fog which conceals the trouble. The best method of control, under these conditions, is to sample and analyze the gas from time to time. If a considerable quantity of CO escapes unburned, the remedy is to increase the pressure in the duct leading to the bridge-wall openings, thus increasing combustion, or to decrease the air pressure in the ashpit, decreasing the gasification. If the analysis shows high O_2 and low CO_2, too much air is being supplied to the bridge-wall duct; the remedy is to decrease the pressure there or to increase the air pressure in the ashpit and increase gasification. Under increasing loads both pressures have to be increased so that the rate of heat generation corresponds to the increased demand for steam. It is impossible to predetermine relations between capacity and the pressures needed in the bridge-wall duct and ashpit, since the fuel bed resistance varies with the ash and clinker burden and with the size of the coal as fired.

Recent Work With the Precise Level Instrument of the U. S. Coast and Geodetic Survey.

By HUGH C. MITCHELL.*

Commencing with the summer of 1900, a new type of geodetic level was used in the precise level work of the U. S. Coast and Geodetic Survey. This new instrument was constructed in the Instrument Division of that bureau, and was designed by Mr. E. G. Fischer, Chief of that Division. Ten years of service have shown this instrument equal to the most stringent demands for accuracy, yet so flexible in its operation that great speed can be made without in the least impairing that high degree of accuracy. For this reason it is well adapted for general engineering work, and already several engineers engaged in private practice have secured instruments of this new type. Geodetic levels of this type have also been secured by the French, Egyptian, Indian, Japanese, and Mexican governments, and by the engineering department of the city of San Francisco, while the U. S. Geological Survey has adopted both the instrument and the methods of the Coast and Geodetic Survey.



THE PRECISE LEVEL INSTRUMENT OF THE COAST AND GEODETIC SURVEY.

This new type of precise level instrument is described in detail in Appendix 3, Coast and Geodetic Survey Report for 1903, commencing on p. 200, and in an article by Mr. John F. Hayford in Engineering News, July 2, 1903, p. 2. Its weight as given therein is 5.2 kg. (11.5 lbs.) for the instrument and 7.2 kg. (15.9 lbs.) for the tripod. Its total weight, therefore, compares favorably with that of many leveling instruments at present used by engineers.

It is constructed of a nickel-iron alloy which has an expansion coefficient of only 0.000004 per degree Centigrade, and which oxidizes very slowly.

The level vial is countersunk into the tube of the telescope, thus bringing it as close as is practicable to the line of collimation, and thereby subjecting it to the same temperature conditions as the other vital parts of the instrument.

The reading device is such, and is so arranged, that the observer can see the level bubble, and the rod at practically the same instant—with no more effort than is required to shift the attention from one eye to the other.

The rod used with this instrument, is a self-reading rod of ✚ cross section, and is just sufficiently charged with paraffin to render it impervious to moisture and yet not of excessive weight.

The use of this level was developed under the direction of Mr. J. F. Hayford, for a number of years Inspector of Geodetic Work in the Coast and Geodetic Survey, and now Director of the School of Engineering at Northwestern University. The instructions prepared by him, under a modified form of which all precise-level work of the Coast and Geodetic Survey is now being done, are designed to secure a standard degree of accuracy with greatest economy of operation; in other words to secure a maximum efficiency. The kernel of these instructions is contained in the following paragraphs:

Except where specific instructions are given to proceed otherwise, all lines are to be leveled independently in both the forward and backward direction.

On all sections upon which the forward and backward measures differ by more than 4 mm. $\sqrt{K}$ (in which K is the distance leveled between adjacent bench marks in kilometers), both the forward and backward measures are to be repeated until two such measures fall within the limit.

The maximum difference in length between a foresight and the corresponding backsight is to be 10 meters.

Other parts of these instructions* have to do with the classes and frequency of bench marks, and with safeguards which experience has shown to be necessary in order to eliminate blunders from the work, either by their prevention, or by their discovery before the line of levels has progressed beyond the locality in which the blunder was made.

Up to the present time, 8,200 miles of precise levels have been run by the Coast and Geodetic Survey, using the present type of instrument. All the work done prior to 1907, both with this new instrument and with the earlier types of precise levels, as well as work by the U. S. Geological Survey, the U. S. Corps of Engineers, and the Baltimore & Ohio Ry. engineers, has been adjusted in one net involving 23,834 miles of leveling, and fixing the elevation above sea level of 9,100 bench marks. To this the Coast and Geodetic Survey is each year adding between 500 and 900 miles of leveling. During the season just passed the line from Fort Worth to El Paso was completed, which gives a second connection between the Gulf of Mexico and the Pacific Ocean.

Regarding the speed which can be made with this instrument it may be said that between 65 and 70 miles of completed (double checked) line per month is not far from the average, while a number of observers have run as much as 100 miles of completed levels in a single month. It is to be remembered, however, that these speeds are for lines run along railroad tracks, using velocipede cars for moving from station to station.

That the use of this instrument is not limited to work of great precision, and that for the demands of general engineering it may be considered far superior to the old wye-level, were demonstrated in the year just ended in a most conclusive way. The loop of precise levels, Crawford-Cheyenne-Pocatello-Butte-Huntley-Cadiz-Crawford, involving 9 seasons' work, and 1,830 miles of levels failed to close by approximately 2 meters, indicating the probability of either one error of 2 meters, or of two errors of one meter each. Office computation and discussion failing to discover the location of the error or errors, it was decided to run a revision line around this loop, beginning at Pocatello, Idaho, and proceeding eastward via Butte, Mont. As the sole object of this revision was the location of errors, the general instructions were so modified as to require only a single continuous line of levels connecting all recovered bench marks, and to require an agreement between the revision line and the old or precise line of levels of less than 45 mm. on sections less than 10 km. in length, while for sections of length greater than 10 km. the limit of agreement was fixed at 15 mm. $\sqrt{K}$ (where K is length of the section in kilometers).

Whenever these limits were exceeded it was required that the section in question be re-run according to precise leveling instructions. In this way two errors of one meter each were discovered, but not until more than half of the loop had been re-run. The interesting part of this revision work is that under the limits allowed less than 5% had to be re-run as precise levels, and that the revision of 940 miles consumed 5.2 months, an average of 180 miles per month. As much as 75 miles of revision levels were run in a single week.

*U. S. Coast and Geodetic Survey, Washington, D. C.

*See Appendix 3, Coast and Geodetic Survey Report, 1903.

Electrolytic Iron.*

By CHARLES F. BURGESS.†

During the past five years investigations carried on in the chemical engineering laboratory of the University of Wisconsin, dealing with electrolytic refining of iron and its use in the production of alloys, about three tons of iron have been refined and over a thousand alloys produced and tested. While this experimental work has been on laboratory scale, it is believed that some of the results indicate the feasibility of employment to commercial state.

The manner in which electrolytic refining has revolutionized the copper industry is now an old story, and electrolysis has likewise become an industrial factor in the metallurgy of silver, gold and lead. Now that it has been found that iron can be refined electrolytically almost as easily as copper, it is pertinent to inquire whether there is a field of usefulness for such iron. This depends upon whether electrolytic iron has superior qualities due to purity or physical condition, and whether it can be procured at low cost.

From the standpoint of purity it must compare with some notable metallurgical developments which have resulted in product such as is being made by the American Rolling Mill Co. in a basic open-hearth process.‡ For this material a purity of 99.94% is claimed, and justifiably so, as some of our analyses show. The electric furnace is another factor which is contributing largely to the control of the composition and purity of iron alloys, and the striking possibilities which are offered in this developing field cannot be overlooked in advocating the development of an electrolytic iron process.

The chief source of commercially pure iron has been, and perhaps now is, the high grade Swedish and Norway iron, used largely as a base material for high grade crucible steel. The analyses of this material usually indicate a high purity, though frequently and erroneously calculated by difference, after determining carbon, sulphur, silicon, phosphorus and manganese. It is not uncommon to find oxides and slag to the extent of 2% in this material, and this impurity undoubtedly may have an influence on the resulting alloys made from it.

We have found that electrolytic iron can be produced with a purity as high as 99.97%, and, perhaps, even better, using extraordinary precautions. This record has been made by using the best commercial grades of pure iron as anodes. A few hundredths of 1% of purity must be sacrificed in using anodes of mild steel or other less pure materials. Electrolytic refining offers a means of reducing or screening out most of the impurities commonly found in iron and of producing a material not only of high purity, but of great uniformity. Even though it may be shown eventually that electrolytic iron may not have a higher purity than that attainable by other methods, the uniformity of its composition should make it a valuable material as a means of eliminating many of the variables with which the crucible steel maker has to contend.

Using an electrolyte containing 40 grams of iron per liter in the form of ferrous sulphate, together with 40 grams of ammonium chloride, it has been found possible to conduct a continuous refining operation for many months at a current density of 6 to 10 amps. per sq. ft. of cathode surface, and at a potential difference of about one volt. The current efficiency is very close to 100%, as it is in copper refining.

This leads to the calculation that 1 KW.-hr. will refine 2 lbs. of iron; or a cost for power of ½-ct. per pound is attainable. The costs for labor, solution maintenance and fixed charges are estimated to be not greater than the power costs, making a cost of refining of about $20 per ton. Assuming the anode material to be a mild steel costing $35 per ton, the cost of electrolytic iron would be in the neighborhood of $55. These approximate calculations indicate that this material might well compete in price with high-grade Swedish iron.

Among the properties of electrolytic iron which may give it some added usefulness is its content of hydrogen and the brittleness which results from this occluded gas. This hydrogen may be of some service in reducing oxides in a melt. The brittleness of the electrolytic iron before the hydrogen is driven off makes it easy to break it up into pieces suitable for introduction into the steel crucibles.

A LARGE CONCRETE BRIDGE is now being built across the Eel River in Humboldt Co., California. It consists of seven 180-ft. reinforced-concrete spans, each with a rise of 26 ft. 4 ins., giving a total length of 1,451 ft. from end to end of abutments. Timber approaches add 1,000 ft. to the total length of the structure. The roadway is 24 ft. in width.

Mr. G. W. Conners, County Engineer, is in charge of the work, and the contract is held by the Pacific Construction Co. The contract price is $245,967 and the date of completion is set at Jan. 1, 1912.

*From a paper read before the Chicago Section of the American Electrochemical Society, Jan. 20, 1911.

†Professor of Applied Electrochemistry, University of Wisconsin, Madison, Wis.

[‡Described in Eng. News, Jan. 6, 1910, p. 6.—Ed.

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The approach of the spring convention season suggests a word of advice to those who are planning to present papers before engineering societies. Our advice is: Be brief and to the point, and to this end prepare yourself beforehand. Only too many authors of papers, in presenting their subject orally to the convention, go about the presentation as though they had given no advance thought to what would be required of them. As a result they bore the audience, fail to make clear the essence of the subject, and often waste so much time as to shut off all discussion.

Under common practice, the time for the presentation of a paper is limited to 20 or 30 minutes, and it is a bit ridiculous to see a man approach this task as though the chairman's announcement was his first intimation of the time limit. Some make no attempt to adjust themselves to this restriction but blindly read ahead until brought up short by the rap of the gavel. Others, somewhat more quickwitted perhaps, skip through their papers, selecting only certain portions to be read. Too often, however, the parts selected are so poorly chosen as to suggest a hasty choice. In exceptional instances some unusually wide-awake engineer will give a more or less carefully considered abstract of his paper, affording his hearers a really definite idea of its chief points.

In view of the fact that the papers are commonly distributed in printed form in advance of the meeting, the method of reading them straight through is a poor one, even when they are short enough to be read completely in the time available. The reading of selected paragraphs may be effective if the paper is well written; but generally the selections must be supplemented by explanatory comments, and a complete abstract delivered without any reading from the paper would be much more satisfactory. Another plan, suggested perhaps by the custom of advance publication, is that of presenting only additional or supplementary information instead of adhering to the material of the paper itself. This assumes that the hearers have taken advantage of the opportunity to read the paper for themselves and have it fresh in their minds, which is not apt to be the case. At best, the bringing forward of additional material may tend to distract attention from the paper's more important points and thus make the subsequent discussion even less unified than usual.

No universal rule can be given for the best method of presenting any and all papers, but in any given case a little reflection should suffice to enable the author to choose the plan to be followed. The chief thing needed is some advance study of the matter of presentation as a problem in itself, and a better recognition of its requirements.

In spite of the enormous increase in the use of Portland cement—an increase that naturally has developed improved methods of production and consequently a better product—the knowledge of the nature and composition of cement is still in that debatable stage where several opposed theories each seem to have some basis of fact. This lack of a complete knowledge has not materially affected the cement industry, to the extent that might be expected. With a view to improving mechanical conditions, cement works managers have added appliances and devised methods in their plants that have served admirably to better the completed cement that is marketed today, but rarely have any of these improvements had behind them any reasons based on some new discovery or theory of the make-up of the cement. It may be that such changes in manufacture will never be realized, that the very complexity of cement composition and peculiarities surrounding its setting are such that no refinements in the process of its manufacture can reduce it to the uniformity we now expect with metals; on the other hand, there is a very real basis for the hope that such improvement may be expected.

It is only in the past few years that the theories of physical chemistry combined with the more advanced laboratory facilities, particularly in high-temperature apparatus, have allowed a development of the study of Portland cement which promises, at least, some solution of the question. Among the few investigators whose researches have been fruitful of rational results, the scientists working at the Geophysical Laboratory of the Carnegie Institution of Washington have recently been most successful, and we are glad to give space in this issue to an abstract of their latest studies. Necessarily, the full account of these studies would be too involved to find space in a journal of the character of Engineering News, but in view of the number of engineers who are interested directly in cement, and thus indirectly in its manufacture, we think that Dr. Shepherd's short abstract may prove of interest. For the benefit of those who are but casually conversant with the present state of cement chemistry, we outline below briefly what these latest experiments and studies tend to show.

Practically all that is known of Portland cement is that it is a compound of lime, silica and alumina, with some minor substances which do not affect its material composition. The relationship of these three major constituents and their exact proportion in the cement clinker has never been definitely determined. Each of the three is a binary compound of an element with oxygen, and although the amount of each may be determined by the ordinary processes of chemistry, the exact nature and amount of the higher combinations of these binary compounds actually existing in the cement are discoverable only by the more difficult methods peculiar to high-temperature observations and crystallographic determinations. For some seven or eight years the Geophysical Laboratory has been engaged in this latter task. The first studies, reported in 1906 and again in 1910, comprised the combination in all possible proportions of, first, silica and lime, then lime and alumina and finally silica and alumina. All possible combinations of these binary forms were studied under high temperature and the phenomena observed and recorded, so as to render possible the recognition of any of the combinations when they might appear in similar analyses of unknown compounds. The latest studies, the results of which are now being made public, consist in the observation of all possible combinations of the three component parts of a Portland cement, lime, alumina and silica. From these syntheses, observation under similar laboratory conditions should reveal the actual composition of cement clinker of similar behavior.

As stated by Dr. Shepherd, the possible compositions of Portland cement clinker seemed to be five, one of which has the appearance of being the normal clinker. This is only a preliminary step toward the final study, which should be able to locate in these clinkers those properties which make them valuable as cementing agents. On the basis of the known make-up of this ideal clinker, there should be developed an acceptable theory of cement setting, which in the present incomplete stage of progress cannot be more than tentative. From knowledge so acquired, undoubtedly practical manufacturing improvements may be expected.

Of secondary importance in this study is the establishment of the existence of a tricalcium-silicate. All the studies culminating with those of Richardson, first published in 1904, though differing materially in many ways, united in deciding that the main cementing constituent in Portland cement is tricalcium-silicate. It was, then, considerable of an upset to these theories when the Geophysical Laboratory experiments of 1906 showed that it was impossible to combine lime and silica by themselves so as to form any such mixture of the two oxides. It is now shown that in the presence of alumina the equilibrium conditions are so modified that the questioned compound may exist in stable form. The Le Chatelier and Michaelis theory that the hardening of cement is due to the decomposition of the tricalcium silicate into calcium silicates of lower lime content, following a preliminary hydration of the tricalcium aluminate, is thus restored to its previous condition of tentative acceptance.

Those who follow the subject of engineering license laws will have taken note of the fact that the movement is in progress at present in several states, in widely separated parts of the country. They will also have concluded that, since the conditions of the world in 1911 are not essentially different from those in preceding years, the flood of license bills is due not so much to pressure of conditions as to a movement, a propaganda, or let us say a fashion. We do not intend this last word in a derogatory meaning, for a fashion may be good, may be health-giving; and we have sincere respect for the opinions of those engineers—not a few, on the whole—who see good in the proposed laws. But it remains a fact that the present situation represents not the meeting of new conditions but a propaganda in which a certain element of partisanship is engaged.

Under such circumstances it follows almost as a necessary conclusion that the reasons back of the different license bills are not of equal validity, and that while good reasons may be brought forward why a license law should pass in one state, these reasons need not apply at all to another state. The contrary is often tacitly assumed, viz.: that the subject has no local bearings and that all the arguments apply equally to license laws everywhere.

The situation in New York State, we desire to point out, is essentially different from that prevailing in most western states. An indication of this may be found in these facts: In some western states, represented for example by Washington, whose present license bill is discussed by a correspondent in this issue, representative sentiment has come out in favor of a State license law, and has cooperated in securing such a law by drafting a good bill. In New York, however, the representatives of the engineering profession stand united against a license law; and on the other hand two specialized organizations have advocated license bills, one being a trade-union of subordinate engineering employees (most of them in the municipal service) and the other an open society of New York City engineering employees. This peculiar situation is made more peculiar by the recent change of front of the trade-union referred to,

whose representative, in a committee hearing this week, proposed to limit the law so as to apply to *civil engineers engaged on public works only.*

The purpose or value of this limitation is a puzzling question. Obviously, most of the general license-law arguments lose their application with such limited scope of the law. It appears that what is really sought is not the safeguarding or ennobling of the engineering profession, but some form of *protection to subordinate engineers in municipal and state service.* These employees already have full protection by elaborate civil service provisions, guarded by a great multiplicity of examinations. Do they find themselves over-protected under the civil service? Does the number of examinations hamper their progress in this service? They are already (through their own efforts in the main) under the protective control of a state board working on the theory that merit alone is to count, and now they seek to place themselves under another state board working toward the same general end. Is the real animus of the matter a desire to throw off the civil-service yoke and substitute a broader, simpler form of fitness badge? Efforts are now being made in some public engineering bureaus of the state to remove part of the civil-service protection, and it is charged that this has political aims. This occurrence is not so far out of harmony with the license-law agitation as to remove all suspicion that the two may be connected.

In studying the corrosion of iron and steel structures there are two points of view, well illustrated by two articles appearing in this issue. From one viewpoint the iron is a complex structure, being attacked by a common and ever-present substance—water. Looking at it this way we would examine the metal to see how we could give it some noble qualities of discouraging the attentions of the water. From the other viewpoint we look at the iron as a stable and enduring material so long as we prevent its joint association with water and oxygen. This would suggest that we spend our efforts in keeping either the water or the oxygen away from the iron.

In following the first plan of progress in decreasing the economic loss through corrosion, improved metallurgical processes have been developed* by which it has been possible commercially to produce an iron, or a steel, of such homogeneity and purity that it rusts far less readily than irons and steels produced by older processes. By the other plan of increasing the life of iron structures, the paint makers are seeking to produce an impervious coating which may be easily applied or one which by its chemical constitution increases the resistance of the iron to being dissolved.

Mr. Falkenburg's experience with the Seattle hot-water pipe installation shows him that the presence of excessive zinc in the pipe metal has been accompanied by perforating of the pipes. Mr. Speller, after having done much to make better pipe possible, concludes that further progress is to come from depriving the water of its burden of oxygen. It is probable that, in the Seattle case, if either better pipe had carried this same hot water or the same pipe had carried oxygen-free water, there would not have been the rapid perforation noted.

Which of these two sorts of remedies is to be looked to in a given case is perhaps an economic question of the cost of a certain amount of protection, furnished by either scheme. In a few cases it may be necessary or desirable to employ both sorts of remedies.

Mr. Speller describes corrosion as a process of iron going into solution and being precipitated out again, as loose rust, by the action of dissolved or suspended oxygen, making place for more iron to be dissolved. Now corrosion, in accordance with this theory, must depend on having a constant supply of oxygen. Experiment has shown that pure iron goes into solution, though slightly, in pure water. Impurity in the iron or water, in general, does not decrease the solvent action so that there must always be a certain theoretical unavoidable corrosion where any fresh supply of water flows through any more or less bare iron pipe—no matter whether the pipe is of the purest of iron or the water is absolutely free of oxygen. Probably this is always a negligible minimum, but that might well be made a demonstrated fact.

Mr. Speller states that the amount of corrosion in a pipe is nearly proportional to the quantity of oxygen brought in with the water. This also sounds like pure theory; at least we have seen no published data establishing this very important relation. These statements then illustrate a curious mixing of theory and known fact which should give way to pure fact before we can intelligently compare the economy of Mr. Speller's proposition, to rid the water of dissolved oxygen, with that of using the highest grades of metal or the best protective coatings.

*Eng. News, Jan 6, 1910, p. 6.

In the good old days when public-service corporations of various kinds got just about all they chose to ask from any city, it was not at all uncommon for franchises running for 99 or even 999 years to be granted. Times have changed since then in more ways than one. Long-term franchises are as a rule now looked upon with great disfavor. It is therefore somewhat surprising to read in the daily papers from Los Angeles, Cal., that the Southern Pacific Railway System is urging a 250-year franchise as a necessary condition of carrying out certain much-needed terminal improvements.

Possible conditions governing improvements of this general class may demand franchise rights covering longer periods than those which most cities are willing to concede for other purposes, but, so far as we can judge from this distance, there is absolutely no justification for a 250-year franchise at Los Angeles. The need seems all the less in view of the fact that there appears to have been formulated a plan for terminal facilities designed to meet the needs of the city as a whole instead of those of a particular seeker after privileges.

We disclaim any knowledge whatever as to the merits or demerits of this plan, but do uphold the general principle that it is for the city in any given case, and not a franchise-seeking company, to lay down the general plan which should be followed in improving terminal facilities. We admit that the task is usually great and complex, and that too often no one representing either the city or the citizens comes forward and proves quite large enough to master the problems in the interest of all concerned—including, of course, the franchise seeker or the one who is to render a given public service, as well as the public which is to be served. As the real condition of affairs comes to be more generally recognized we may expect to see cities, citizens and franchise-seeking corporations alike rising to a broader view of the subject and cooperating for the good of all concerned, instead of seeking merely for the benefit of a single class.

Scientific Management.

In the dozen years or so since Taylor's ideas on shop management, and the related ideas of other workers, have been actively under discussion among engineers, the subject has at all times been treated sanely, even when the discussion waxed most enthusiastic. Recently, however, it has been made a subject of popular sensationalism, in part through the effort of lawyer Brandeis to make capital in favor of low railway rates out of the zealous propaganda of followers of the new ideas.

The assertion that three-quarters of a million dollars a day could be saved by the railways of the country if only they were run right, capped the climax. At the same time it removed the glamor of mysticism from the Brandeis incident; for who is not familiar with the type of man who could run his neighbor's business ever so much better than the neighbor runs it? But in spite of this revelation, the transfer of the discussion from a sane and technical footing to the stage of fanaticism is extremely unfortunate. The situation is made worse by the fact that the subject has become involved in a mass of high-sounding verbiage which effectively clouds whatever may be within. It is desirable that some of this phraseology be examined so that its misleading character be appreciated, in order that a proper estimation of the subject may become possible. We will endeavor to do this by referring to one or two typical examples of such verbiage.

The ranks of the modernizers or efficiency engineers contain men of various degrees of ability and the ideas and methods they represent are widely diverse. All of them came after Taylor, however, and it is the movement which his followers represent that concerns us. We do not here propose to consider that class of modernizers who make a business of examining tools to see that they are in proper working order, or rearranging plant and procedure to secure more orderly and less wasteful working. These men offer no novelty, since it has always been well known that a carpenter, for example, works most efficiently when his tools are in good order and systematically arranged and his materials are laid ready to hand. We are concerned only with those who claim to represent a radically new movement, the propagandists of "scientific management."

One of the commonest expressions from this group of modernizers may be typified by the following assertion:

"Our method is a means of multiplying output and at the same time reducing cost of production, while yielding a largely-increased return to the worker without requiring him to work harder; and incidentally we eliminate friction and contentious spirit."

It is not hard to recognize in such words the features of an advertising "blurb." Couched in terms of paradox, they have that flavor of breezy boasting which has ever distinguished the charlatan. They are apt to awaken distrust rather than carry conviction. Taking them without prejudice, however, they appear useless either for giving information or as a basis for analysis and discussion, and must be eliminated at the start.

The term "efficiency" is constantly heard in connection with this modern management movement. Its votaries are apt to call themselves "efficiency engineers," and to talk about introducing "efficiency" into a shop or other field of labor. Does the word carry in itself a definition, a characterization? Does it express something distinctive, something new? Or is it but a name, like a brand or trademark? This question is important, because everyone will concede that high efficiency is admirable in all cases, that it represents an object universally recognized as worth striving for.

Now, the study of efficiency, the effort to attain efficient performance, is not a new thing; far from it. It is one of the oldest things in the world. Since the early dawn, men have worked, and under a natural, inherent stimulus they have always sought to achieve the desired result with minimum exertion; this, however, is seeking to work efficiently. So also, in the ages since men first set other men to work for them, they have (under another very natural stimulus) sought to get maximum results from the day's work of each man; that is, they have tried to convert a given outlay of time and labor on the part of the employee into the largest attainable result. This also represents a striving for high efficiency: the endeavor to make their hired labor as fruitful, i. e., as efficient, as possible.

Surely the men who now step forward and proclaim themselves as "efficiency engineers," and their goal as "industrial efficiency," present no new endeavor! Efficiency is not a new cult, whether in machine-shop work, or in bricklaying, or in railway operation. If they offer anything new, it is not in the nature of their goal but in the methods by which they propose to attain it. So ridiculously obvious is this fact that its mere mention might seem waste of time. And yet there is real danger that the insistent pressing forward of the efficiency modernizers may make us forget that their ware, the novelty

which they have to sell, is *not* efficiency but (if anything) a new and alluring way of getting efficiency. Their self-given title "efficiency engineers" is misleading; it should read "efficiency-by-a-new-method engineers."

There is an important thing to remember at this juncture, namely: that in the effort toward increased efficiency which, as remarked, has been in progress since the world began, the most varied means and methods have been tried. Every device of human ingenuity has been called into play. Kindliness and cruelty, high rates of pay and low rates of pay, the selection of the most intelligent grade of workers or of the most machine-like, free or undirected working and carefully supervised drilling, steady-pay and reward schemes, have all been experimented with. Present-day methods of working represent on the whole the outcome of the many past trials; not necessarily a crystallization of the methods which proved best (for good performances often are forgotten and bad precedents are followed in ignorance and misunderstanding), but tending largely toward this point. The methods proposed by the modern propagandists apparently claim to be something wholly new, something quite beyond this varied past experience.

We find this claim reflected also in the term: "scientific management," a term made particularly prominent in the Brandeis argument and popularized by articles setting forth its magic to laymen.

As we have already suggested, the art of managing the work of others is old. Just as old is the endeavor to conduct management efficiently by the application of knowledge, intelligence, keen scrutiny of operating relations, and even the genius which often goes beyond all these. "Scientific management" must mean something quite beyond this. It can have no other meaning than that, by study based on observation, certain general laws have been derived, whose intelligent application is capable of yielding results outstripping those of past practice; *not*, be it noted, that one man or another did actually achieve certain unprecedented results, but that back of such results lies a rational formulary, a set of known principles having logical interconnection, which enables others to attain similar excellence of management. More than this: Since the term "scientific management," as currently used, is not limited to particular applications, but indeed is claimed to have universal scope, this alleged science must consist not of principles of accounting control, or principles of sales management, or principles of shop administration, or principles of contracting management, but broadly of principles of management *per se*. Who that is familiar with the complex and ever-new problems, both human and mechanical, which arise in managerial work can recognize here a field for the development of a "science"? Of course mere accounting systems, forms for cost-determining records, schedules of routine and the like, however helpful as methods, are not science, nor do they even constitute management.

If a true *science* of management has been developed—though we have no knowledge of the existence of such a science, nor do we clearly perceive its possibility—is it credible that it should have been even fragmentarily in existence for five or ten years and no manual, text or treatise setting it forth should be before the reading world? Such a science being of universal application and therefore unhampered and uncomplicated by the individual characteristics of different occupations or fields of labor, and being furthermore free from the tedious intricacies of mathematical evolution, could not be a long or involved thing, but would be contained by a small, simple book. No such book has come to our view. Frankly, we are skeptical as to the existence of the alleged "science."

A point never to be lost sight of in considering such a subject as management is that the managing ability, i. e., the ability to secure efficient work from others, is a personal, individual attribute. It is like success, founded on a gift and not on acquirements, by virtue of which some may rise and others may not. Just as the general who leads his armies to victory is born, not made in the academy, so the manager of men and industries is born to the work. The Napoleonic characteristics are inherent, they do not come by instruction; and Napoleon himself was not able to transmit the gift to his colleagues.

Brilliant work has been done by such men as Taylor and Gantt in reforming particular industrial institutions, in creating conditions favorable to efficient work on the part of the employees, and in setting up a managerial routine by which the high results they themselves could secure were (not *perpetuated*, for only the long test of time could justify this word, but) made to outlast their personal presence. By these achievements they have fairly earned all the high praise that has been accorded. As in the case of other successful managers, they earn the reward not merely of success but also of admiration. And like some other successful managers they merit extra appreciation because of the marvelous showing that their personal gifts enable them to manage radically different enterprises with the same pre-eminent success. Yet in the case of these men it was thought necessary, partly because the procedure adopted in the successful work was original, to explain their successes by the discovery of new principles of management, instead of attributing it to personality as would be done in the case of others. History clearly evidences the individual character of the great achievements of generalship, administration and managerial control. In every case, the explanation of Napoleon is found in Napoleon, rather than in his procedures. Must we seek other explanations in the case of our "efficiency" geniuses?

But it is alleged that though business under the intense stress of competition and with the backing of modern intelligence is no doubt quite efficient, yet revolutionary increase of efficiency had been accomplished by the new-movement men in every case they took hold of; and that this fact represents clear evidence of the iconoclastic novelty of their system. The deduction is also drawn herefrom that every latitude in belief and acceptance should be given to their claims and pleas. In a more veiled way, hints are thrown out that at the cost of but a free submission to the dictates of the new movement, the world may be set so far forward on its path that mankind may perhaps attain to an early millennium. These claims do not carry the impress of naturalness; they do not appeal to common sense.

The fact is that of the multitude of human affairs probably only a very small fraction is conducted with good efficiency. In every field, from running a department-store to directing a manufacturing corporation, the widest variation of directive skill exists. Presumably, if all department-stores in a given city were managed with equal ability, all would have about the same degree of success; if all engine-builders operated their works with the same degree of efficiency, all would prosper equally. And of course the fact is that they do not. Difference of opinion may arise on the question of why. But though some should assert that in each case of pre-eminent success (high efficiency) the reason lies in some system or method or controlling procedure there in vogue, yet we feel certain that common sense warrants us in attributing the result to the man—or men—who are in charge. The personality of that man (or the joint personality of several) is the real forward-pushing force. His particular methods are not ultimately responsible; while they are indeed momentarily the tool by which he achieves success, yet the same man if compelled to abandon that particular tool, that particular method, or if placed in another environment where that method no longer suits, would still be successful.

The "new movement" men, be it noted, claim to command success through other influences than individual characteristics. The essence of their case is that they have certain principles, or rules of action (which incidentally may be taught to others or enjoined on them by specific orders) whereby success is perforce brought about. We submit that these claims must be subjected to the considerations of common sense which ordinary men will apply to any other claim of radical novelty or extravagant appearance.

We have in the above endeavored, not to assail the work and teachings of the Taylor school, but only to clear away an encumbrance of misleading words, for which perhaps the real men back of the work are not at all responsible. We have tried to point out that common sense should be applied to the subject without reserve, so that it may be possible to see the kernel of the matter clearly. This same procedure, we submit, must be applied in the detail consideration of the several methods or devices which the new-movement men advocate. The claims of time-study (or motion-study), of the instruction-card method, of the functional foremanship system, of the task-and-reward method, should be scrutinized always with the use of common sense. And if this is done, we believe many extravagances of discussion can be avoided.

For example, much has been made of the assertion that a given task-and-reward arrangement constituted "a piecework system in which the rate *cannot* be cut." Asserting an impossibility is never very plausible; and in this instance the chances are all in favor of the opposite impossibility, namely, that a payment whose rate may be maintained permanently against all external and internal influences is impossible. Of the same type is the statement that certain output-increasing methods involve no "driving" of the worker, and that, if anything, they form a bar to all driving. Common sense will lead us to be skeptical as to such assertions. It will suggest the question: What will be the condition when more than merely isolated works have applied the new method, when competition exerts its pressure, when the common standard of 100% working has been raised to the advanced output credited to the managerial reforms? Will the worker still be able to earn more than day wages, when performing at a normal rate of exertion? Will he be free from "driving" influences? And even before this stage is reached, are we to believe that a system based on the spur of a bonus, a tipping system as it were, contains no elements of driving?

We look forward hopefully toward abandonment of the sensationalistic campaign for industrial improvements and a return to sane discussion. If the deception of extravagant phrases can be removed, and common sense applied in all consideration of the subject, we doubt not that this result will be attained. Progress toward realizing whatever benefits reside in the new movement will then be unhampered.

LETTERS TO THE EDITOR.

Cross-Section of Car-Track Streets.

Sir: Having occasion to look up the subject of the cross-section of car-track streets in the paving text-books and in the recent volumes of Engineering News I have noted that very little is said on this subject except in the special cases of irregular sidewalk elevations. If mentioned at all, the method proposed for laying out the cross-section of a car-track street, with the gutters at approximately the same level, is to consider the roadway between the tracks and the gutter as half of an ordinary street of twice the width of this strip.

This cross-section should be determined without reference to the shape of a trackless street. The car tracks form a flat portion in the middle of the street which does away with the necessity for any curve to connect the slopes on the sides, and, assuming the car tracks high enough above the gutters to give the proper slope for the kind of pavement used, the only remaining reason for making the line from the tracks to the gutter anything but straight is the appearance. If it were a perfectly straight line the surface would appear to be sagged. To overcome this a very slight departure from a straight line is necessary, not more than ¾-in. in a width of 20 ft.

Keeping to this nearly straight line will do away with the extra steepness at the gutter and the flatness next the tracks, which result from treating it as the half of a trackless street, and consequently distribute the traffic which on a car-track street of ordinary width is at best well concentrated. The portion near the gutter will be brought more into use and thus relieve the portion near the tracks, which otherwise would get more than its share. It will also lessen the

necessary total rise from gutter to track since there will be no great amount of flattening as the rail is approached.

When the street is paved with one material over its whole width, the slope of the sides may be unbroken from the rail to the gutter, but when the track portion, including a narrow strip outside the rails, is paved with some sort of block pavement and the sides of the street with a bituminous sheet pavement a different cross-section should be used. This is because of the joint between the blocks and the sheet pavement. A joint is a vulnerable part of any pavement and hence should be favored as far as possible. With a bituminous sheet pavement it is essential that full compression be obtained at this joint. If it is not given at the time of construction it will be given by the street traffic later and the result will be a rut along the edge of the blocks. This is a very common fault in streets of this sort.

To get this compression during construction is almost impossible unless the surface material is held a shade higher than the blocks, since otherwise the weight of the roller or tamper will be supported at this point by the edge of the blocks rather than by the surface mixture. It is next to impossible, especially if the mixture contains large particles, to rake it to such a nicety that when perfectly compressed it will be exactly flush with the blocks. If left lower than the blocks, even if perfectly compressed, wheels passing from the blocks to the sheet pavement will by their pounding in warm weather start a depression which will grow at an increasing rate.

If the sheet pavement is held any higher than the blocks it will be impossible for water to flow from the blocks over the sheet pavement to the gutter and the result will be that little puddles of water will lie along the blocks outside the rail or a little stream of water flow along the joint—a bad thing for both sides of the joint.

To get over these difficulties the blocks outside the rail should be sloped toward the rail. The sheet pavement could then be held slightly higher than the blocks while the water falling on the narrow strip outside the rail will flow to the rail groove.

When the tread of the car wheels is wider than the head of the rails, the wheels in wearing will sometimes take a shape that causes them to bear upon the first row of blocks outside of the rail, in time wearing a groove in the blocks. For this reason it is well to extend the water gratings, which should be placed between the rails opposite every street catchpit, to the outside of the rails.

J. G. Clarke.

20 High St., Southbridge, Mass., March 6, 1911.

Western Views on License Laws for Engineers.

Sir: In the matter of the licensing of civil engineers and surveyors, will you kindly permit me to point out what appears to me as fallacy in much of the argument that is advanced against the desirability of such legislation.

It has been assumed that an examination must be, necessarily and exclusively, an educational examination, and that the technically or college-trained man would have an unwarranted advantage over the so-called practically trained man. Such is not at all the case, for any proper examination may and should take cognizance of practical experience as well as educational qualifications, and these should be so weighted in their rating as to afford no undue advantage to either. As illustrative of a practical provision covering this feature let me quote from a license bill now under consideration by the legislature of this State:

An applicant for a license to practice civil engineering who has otherwise complied with the provisions of this Act, must, before a license can be issued to him, attain a final rating of at least 70 in an examination before the Board in practical experience and in the technical subjects taught in one of the courses of an engineering college of recognized standing. The markings in each subject of the examination shall be on the basis of 100 for perfect and 0 for total failure, and the final rating shall be obtained by adding together 35% of the markings for practical experience and 65% of the average of all the markings for educational subjects.

The above provision demands, on the one hand, that a man shall have a fair knowledge of the fundamental theories of engineering, no matter what the length or character of his practical experience, and, on the other hand, it demands that he shall have a broader knowledge of those fundamental principles to the extent that his practical experience may be deficient though, as provided elsewhere in the bill, this practical experience may not in any event be of less length than six years. I believe every one will concede the fairness of the above provision as to all classes of engineers, and also its tendency to eliminate the wholly unfit or ill qualified from independent, responsible practice of the profession, restricting them to subordinate work under the direction of men qualified to direct.

A second fallacy is the assertion that the issuance of a license will mislead the public into the belief that the State in effect guarantees that the holder of such license is proficient in all branches of engineering. I know of no proposed bill that carries that impression actually or impliedly, and I see no basis whatever for assuming that the public would so interpret it. The public applies no such reasoning to either the medical or legal profession, in both of which the license system obtains. No one would think of calling in an eye-and-ear specialist to treat a case of appendicitis, nor a patent attorney to try a divorce suit, and no more would he be likely to engage a sanitary engineer to design a cantilever bridge. Even if there were such a tendency it would soon be overcome by education of the public, and by the fact that engineers confirmed in their profession by the process of selection which the license system implies would not be likely to abuse the confidence of their clients.

Furthermore, the public would suffer no more confusion in choice of engineers than obtains at present, for under the proposed dispensation all engineers, except those in subordinate capacity, would be licensed, and the probability of the public securing an incompetent engineer would be greatly reduced.

Every one admits the legitimacy of the license system as applied to the medical profession and recognizes what saturnalia of malpractice would prevail were the medical bars thrown down and every one who so desired permitted to practice without hindrance. Our attitude in this case proceeds from the fact that human life is concerned, and yet I seriously question whether statistics will sustain the assumption that more lives may be menaced by malpractice of medicine than by malpractice of engineering, for the former reaches individuals only while the latter more often strikes the mass.

That a license bill for engineers presents some difficulties is obvious, but I frankly believe a bill may be so framed as to wholly overcome or effectively minimize these difficulties. The matter of examinations and possible misconception on the part of the public as to the significance of the license I have already considered. The matter of curtailing one's practice outside his own state is admittedly important, but may be satisfactorily met by exempting alien engineers when engaged in purely consultative work or if engaged in actual construction or administrative work, by means of a temporary license to be effective until examination may be conveniently taken or by a reciprocal license issued in recognition of a license held from some other state. The reciprocal license idea coupled with gradual extension of license requirement in the several states would soon remove the objection complained of as to simultaneous practice in more than one state.

It has been contended by some that the national engineering societies afford a sufficient protection to the public if the public would but differentiate between members and non-members; and again that, if a license law is adopted, members of such societies should be exempt from examination requirements. To the first contention I would reply that the public knows practically nothing of these societies, in fact is generally ignorant of their existence and therefore differentiation as between members and non-members is impossible. To the second contention I would reply that a question of constitutionality may be involved, and if not this, then there is at least grave doubt as to the wisdom or propriety of a state giving specific recognition in its laws to alien institutions over which it can exercise no control.

Engineering should more and more become a scientific profession, guided and controlled by scientifically trained men, and I believe the majority of engineers wish to see it become in fact instead of fancy, a learned profession and wish to see it so regarded by the general public. This can only be accomplished by insisting upon a high standard of admission to the profession, and it seems to me the license system tends exactly in that direction. A license law, conservatively drawn, can not possibly debar any one from practicing who by any reasonable criteria as to necessary qualifications should be permitted to practice; but it can debar the unworthy, the incompetent, the charlatan. It will prove an incentive to the better study and practice of the profession. It will afford a clearing house of statistical data as to the character and extent of engineering practice within the state. Its maintenance cost will be relatively so small as to at once disarm the charge of its being a burdensome tax on the profession.

If its tendency is to improve the character of the engineering personnel (as I believe it is), and therefore the quality of engineering work, the public must inevitably be the gainer. And that it may incidentally conserve the practice and the emoluments thereof to reputable and competent engineers is no legitimate objection to the license system.

A license bill is now under consideration by the legislature of this State. This bill was prepared by a special committee of the Pacific Northwest Society of Engineers and received the endorsement of that society. The committee which prepared the bill was composed of six members, four of whom were members of the American Society of Civil Engineers, and of these four three favor a license bill. Although I should like to see the bill changed in some respects I regard it on the whole as the best license bill that has yet come under my observation.

Very respectfully yours,

Joseph Jacobs, M. Am. Soc. C. E.

Central Bldg., Seattle, Wash., March 2, 1911.

[A copy of the bill, sent with the above letter, shows that some of its main provisions differ from other than quoted in the letter are:

Definition of civil engineering as including of all engineering other than military, and engineering "the designing and construction of public or private utilities." Only those who practice "in a responsible capacity," i. e., "those exercising authority or commissioned to exercise discretion or independent judgment," come under the act.

Separation of civil engineering and surveying with separate examination and license for surveyors. The license fee for civil engineers is $20, and that for surveyors is $10. Licenses are in force five years as a maximum, and renewal requires repeating the fee but not the examination.

A State Board of Engineering Examiners shall consist of the State Engineer and two members appointed by the governor for two years.

Active practice of civil engineering for two years prior to the passage of the Act, or of surveying for one year, is sufficient requirement for issuance of a license on payment of fee, if application is made before a fixed date.

Applicants for examination must have six years practical experience in civil engineering or three years in surveying, a year's credits in a satisfactory engineering college to count as a year of experience.

Licenses may be granted without examination to holders of licenses from other States where satisfactory requirements are imposed. Temporary licenses may be issued to satisfactory applicants before examination.

The Board must revoke a license on proof of incompetence or misconduct.

Appeal from decisions of the Board will lie to any County Superior Court and thence to the State Supreme Court.

The other provisions are coherent and consistent auxiliaries to these.—Ed.]

Sir: I have noted with interest the various letters and editorial comments regarding the proposed licensing of engineers, published in Engineering News recently, and am very glad that the News has taken the stand it has in the matter. It is also gratifying to note that the engineering societies which have considered the matter, and a majority of the correspondents, take a similar stand.

Of those who have written in favor of the proposed license laws, it is noteworthy that, with few if any exceptions, they have based their beliefs on some sentimental inclination, or on the fact that in some one locality, or for some one kind of work, there may be reason to believe that a license law would do some good.

I think the most remarkable example of "meaningless nothingness" that I ever read is the first letter on the subject of license laws in the Engineering News of March 2, 1911. If the correspondent had told why your editorials do "not ring true under the hammer test" or had applied a hammer test as an example, instead of expressing his admiration for those "skilled in the grand specialty of obstetrics," his letter might have been more convincing. Similarly, after telling of his great pleasure in listening to a professor in "his earnest presentation of facts in unstinted support of the McGrath bill," he drifts into sentimentalities again and tells of the pleasure of being assisted into existence by a licensed doctor and of his hope of being assisted out by a licensed undertaker, instead of telling us what some of the professor's "facts" are. Poets and musicians, and even all other people under certain circumstances, may greatly enjoy pondering over these beautiful sentiments, but they do not impress one as weighty reasons for collecting license fees from engineers.

This same correspondent refers to "the sentiments so splendidly expressed by Mr. W. Newbrough." Mr. Newbrough will doubtless be glad that the sentiments expressed are mostly in the other man's letter and that he himself had the good fortune to state certain "facts." But Mr. Newbrough's argument, if analyzed, will be found to agree with the concession made by the editors of the News that certain licenses for certain surveyors may be needed. Doubtless, if a license law ever goes into effect, it will do so ostensibly as a measure to protect the public. One of the few classes of engineering work with which the uninformed public has to deal directly is such work as that referred to by Mr. Newbrough, done by surveyors who are employed by farmers to build irrigation ditches. But as such work is mainly local and only one license for it would be needed by any one engineer, no great hardship would be worked by a requirement that a man to do such work should prove his ability to make a correct survey.

It seems to me that a point of much importance, in considering the licensing of engineers as a protective measure, and one which has been sufficiently emphasized,

is that very few engineers deal directly with the public. What engineer was ever engaged to build a bridge or a skyscraper or to be chief engineer of a railroad, who had not first proven his ability in such a way that his prospective employers would never think of asking to see his license certificate even if he had one? The reasons for licensing doctors do not apply in the case of engineers. If one of our legislators, who thinks the public needs protection and who is not himself an engineer (and few, if any, legislators are) will try the experiment of emptying his pockets of all cash and undertaking to support himself for a year by doing engineering work, I think he will agree at the end of that time that the state does not need to license engineers to protect the public against him.

If it can be shown that a license for engineers would accomplish any good, I think that few engineers would object to a reasonable fee for a license in one state. No engineer would relish the idea of having to spend $1,000 for license fees in forty states and perhaps a year's time under heavy expenses while taking examinations.

It has been pointed out by you that the successful passing of an examination is not a proof of ability. I would suggest that if we are to have license laws, they would be fairer to the engineer if they provide for the use of a license from any state in any other state, and more effective as a protective measure if, instead of the examinations proposed, the applicant be required to show that he has had continuous employment as an engineer with one company for twelve months at some reasonable salary.

But I fear that a measure which provided for a free license in one state to the holder of a license from another state would reduce the hoped-for "efficiency," as a revenue producer, of the proposed license, to such an extent that our legislators would lose their admiration for it as a protective measure. The requirement of a separate fee and perhaps a separate examination in each state in which an engineer has occasion to work would be nearly equivalent to a law forbidding the practice of engineering. Here again, we find a difference between the circumstances of a doctor and those of an engineer. A doctor seldom goes ten miles from his office, while an engineer is lucky if he stays long enough in one state to obtain a voting privilege. (Perhaps I should not call attention to this last fact for fear it may cause our legislators to take less interest in the welfare of the engineer.) I think a little reflection will convince any one that in the consideration of licenses for engineers, any reference to licenses for doctors and lawyers is entirely untenable.

I have no sympathy with the "dignity" arguments which have been advanced. I know of no one, except the doctors and lawyers themselves, who considers that an engineer, as such, is less respectable a man than the doctor or lawyer. The sentimental arguments are no better. The average engineer is so practical a man that he takes more pleasure in the fact that a bridge he has built stands up while a train runs over it, than that it affords him a structure on which he may hang a framed copy of his license certificate.

The utter impossibility of designing a license measure which will in the smallest degree protect the public, even if it does not actually have the opposite effect, and at the same time cover all branches of engineering except military, has been well brought out in your editorials and in one or two letters.

I very much hope that no such laws as those proposed will ever go into effect. I do not see how they can do any good except as state revenue producers, and all will agree that if passed for that purpose alone they would be utterly unfair. That they would act as immense obstructions in the way of engineering practice and progress can hardly be denied.

H. M. Bowers.

Georgetown, Cal., March 10, 1911.

The New York State License Law Attempt.

Sir: A bulletin has been issued by the executive committee of "The Technical League," dated New York, Feb. 15, 1911, in support of the passage of Assembly Bill No. 96 known as the McGrath Bill or "Technical League Bill."

In this bulletin the bill is described as "A bill to make civil engineering a profession like law, theology, medicine, dentistry and pharmacy" by obliging civil engineers to become licensed before allowing them to practice. There are so many fallacies in this bulletin that the following brief has been prepared to clear up the subject.

The general arguments which have been advanced on behalf of bills licensing civil engineers are briefly: First, that it will make engineering a profession like the law and medicine; and second, that the public safety requires that only competent engineers be permitted to practice. As both of these arguments assume facts and conditions that do not exist it is not surprising that incorrect conclusions be drawn from them and bills like the present are introduced.

It can safely be said that it is not wise to legislate if there be no reason for enacting the law, and that least of all is it wise to rearrange conditions of professional and business life by law when for years past they have been successfully conducted without legislation. The arguments for the present bill do not show any real, substantial, fundamental reason for revolutionizing the civil engineering profession.

In the first place the present law will not make civil engineering a profession. It will not, because civil engineering has been a profession for over two thousand years. From the Roman time down to date, engineers have been a trained body of men, earning their living not like merchants, by buying and selling goods, but like doctors and lawyers, by selling their learning and ability, that means their profession. They were not laborers nor mechanics but professional men. Civil engineering as a profession is as old as that of medicine, which in turn is as old as history. For any one to speak of making civil engineering a profession in 1910 by this law is to betray the profoundest ignorance of its nature, the history and the standing of civil engineering.

In fact the very contrary endeavor can readily be spelled out of some of the language of the bill, in an endeavor to reduce civil engineering from a profession to a trade, and to license the practitioners like chauffeurs, barbers and peddlers. The act goes so far as to require photographs of engineers to be sent with applications, a sort of Rogues Gallery measure, and one which is never used except as a matter of police protection. This is not demanded of those permitted to practise law, and to demand it of engineers who have an equally high standing in the community is a distinct and unworthy reflection upon the whole engineering profession of the state.

It is so manifest that there is nothing to the argument of making civil engineering a profession by law, that it may be better inquired what reason there is on the ground of public safety for reconstructing the entire operation of the engineering profession at this time.

It would naturally be supposed that any one advocating licensing a profession on the grounds of protection to the public would be able to demonstrate that the profession as at present existing was either guilty of flagrantly endangering the public safety, or was a menace to it, and that the public needed protection from it. When quack physicians were a menace to the public by malpractice and gross ignorance it was necessary to protect the public. But the laws controlling the licensing of the practise of medicine were passed because it is a well-known fact that for centuries quacks and charlatans of all sorts imposed upon the public, and their existence was a danger. This cannot be said of civil engineering. It is absolutely impossible to say that the engineering profession by its ignorance has imposed on the public. There is no profession in the world that has a higher standing for efficiency and in which a mistake is so costly to the practitioner. In medicine a mistake may be excused by the uncertainty of human life; in law it may be excused by the uncertainties of the decisions of the courts; but in engineering there is no excuse, and it is common knowledge that the mistake of an engineer in a matter of construction means the practical termination of his career as an engineer. No one will thereafter employ him.

The conditions which made necessary the licensing of physicians never did and never can exist in engineering. Those advocating the present bill will not do so on the ground that ignorance or inefficiency of the engineer is endangering the public, because they cannot do so. In the record of the profession, in operations involving hundreds of millions, there is absolutely nothing on which to base an argument that the profession needs an examination and a license before it is competent to practice. The record belies that.

It can only be said that the public needs protection of some sort because of new conditions arriving out of the greater growth of the profession and its greater employment. An examination of the nature of the engineering profession as it now is and of its own regulation will show how impractical and how fallacious this argument is.

In the first place it is fallacious to draw any analogy from the licensing of the collateral professions of the law and medicine. Everybody, the rich and poor alike, must go to the lawyer and doctor. They are almost the necessities of life to every one. They exist in far greater numbers than civil engineers. There is only one small branch of the engineering profession which is in similar public demand, that is the land surveyor, and for the purpose of preserving accurate court records there is no reason why he should not be licensed. But with the civil engineer broadly speaking the facts are entirely different. He is not a necessity to the rich and poor alike; he is only needful to those who have substantial sums of money to spend and who can inquire at their leisure into the reputation and qualifications of an engineer before they employ him exactly as they can inquire into the qualifications of a musician or a painter. The relations between the public and engineers are so fundamentally different from those between the public and doctor and lawyer that no analogy can be drawn. This is especially true in regard to the law. Attorneys are not licensed to protect the public, but for the benefit of the courts, and at their discretion. The courts can have their choice of attorneys on educational or any other qualifications they wish, and could to-morrow abolish the licensed class of attorneys at law and permit the general public to practice law. How can it avail to argue from this that engineers should be licensed?

Moreover those who to-day wish to employ engineers have a far greater protection against incompetency than any state license would give them, by virtue of the voluntary organizations of the engineers themselves. There exist in the engineering profession great national and international societies such as exist in no other profession. The Institution of Civil Engineers of Great Britain is an international society 86 years of age. The Boston Society of Civil Engineers is a national society about 65 years of age. The American Society of Civil Engineers is a national society of about 60 years of age. The Canadian Society of Civil Engineers is 25 years old, the American Society of Mechanical Engineers is 30 years old, the American Institute of Mining Engineers is 41 years old, and the American Institute of Electrical Engineers is 37 years old; and there are many other like societies of civil engineers. Membership in these societies is based on merit and experience only; practically, on experience. It is impossible for a young engineer to become a member of one of these societies until he shall have passed a certain number of years in actual work, and shall be certified as competent by corporate members of the society. By this means alone a person may inform himself of the standing of an engineer and whether he is reputable and efficient.

Furthermore there are over one hundred different and distinct subdivisions of civil engineering, each one of which is and has been the life work of engineers, and for the state to certify to the public by its license that the holder is competent to practice any one of these numerous branches of engineering is to certify something palpably false, and is a fraud upon the public, instead of a benefit to it.

It would seem clear from the above that arguments based on the idea of creating a profession, or on the idea of promoting public safety, are unfounded and cannot be supported because totally misconceived. But in addition to the fact that such a law as the present would work exceeding hardship on the profession by restricting its usefulness (as the profession is one in which an engineer frequently works in a dozen states at one time on different employments and in three or four states in one employment at the same time), there are other errors which show that the law would work against the interests of the state, the engineers in the state, and the public.

If such laws as the present are to be passed they will soon be passed in 48 different states. As a matter of policy New York will be compelled to recognize licenses granted by other states to their engineers, or else all the engineers of New York state, where the greatest number in the country are located, will be excluded from the other states. This reciprocal feature is inevitable. What will result? The 48 different laws will vary; the examinations will vary and some will be much easier. Engineers will then be able to take examinations in easy states and enter New York to practice on their license. Then the New York standard will be defeated and we will have the same situation as with our corporation laws, with our Arizona and Delaware corporations doing business here, and as with our divorce laws, with Nevada divorces valid in this state. Only it will be infinitely worse, as a license to be an engineer is something based on education and ability, and has the endorsement of the state, and it will be exceedingly dangerous for this state to be required to indorse by implication the qualifications of engineers from everywhere. That would defeat the whole purpose of licensing.

As a practical matter a license will mean nothing to the man who employs the engineer. He will employ him as always heretofore on his known merits. The engineering profession protects itself and the public to-day by the standards it sets up in its societies. In the face of this there is no reason for so fundamentally overturning the conditions of the practice of engineering where there is so little to be gained, and the danger of a fraud on the public so evident.

I may add that substantially the above-given considerations were included in the briefs presented to the Assembly Committee in charge of the McGrath bill.

Geo. B. Francis,

10 Bridge St., New York City, March 15, 1911.

Sir: Some of the letters regarding the licensing of engineers, notably that of Mr. W. Newbrough, M. Am. Soc. C. E., of Evanston, Wyo., in Engineering News of Feb. 23, 1911, indicate misconception of the scope of the proposed legislation in New York and also of the grounds of opposition thereto.

Mr. Newbrough's consideration of the matters seems confined almost wholly to surveying and simple irrigation ditching.

There is no objection to licensing surveyors. In fact, some legal regulation of land surveyors, such as prevails in Canada, would be reasonable and proper. Such surveyors deal with all classes of people, ignorant as well as intelligent, and their work has to go into legal in-

struments and pass through generations as original records, behind which it is often impossible to go. Qualifications for surveying are definite and easy to establish; furthermore, there have been in this class of work a great many abuses, which, under existing conditions, can only be minimized by previous determination of the fitness of the surveyor to do such work.

But to extend this principle to the engineering profession in its broader sense, involving design, supervision, construction, operation and maintenance, is unnecessary and impracticable and certain to produce trouble.

In all parts of the United States methods of design, construction, operation and maintenance, in so far as they affect public safety and health, are more or less subject to supervision and control by legally delegated authorities. Such supervision and control are applied to the physical, tangible features of work, where proper standards can be set, and where conditions can be physically demonstrated. If the attempt is made to carry the supervision and control back into the minds and capabilities of the engineers doing the work, an impossible task will be undertaken. Examinations, written or oral, are not conclusive indications of fitness or unfitness. No man nor set of men can qualify to properly supersede the prevailing business methods, and the labor of the various engineering societies in furnishing means for the public as well as for members of the profession to determine the fitness or unfitness of engineers for the limitless varieties of function embraced in all classes of engineering.

Law and medicine are not analogous to engineering. The practice of these professions involve the ignorant and helpless, whose lives, liberty and property would be at the mercy of an army of crooks were these not barred by law from practice. The works of lawyers and doctors are not susceptible of the same scrutiny and standardization as those of engineers. And yet all the legal restraints thrown around these professions only bar the petty criminals; serious malpractice is perpetrated by those who can easily leap over the low license barrier, and can only be restrained by the rules of ethics and honorable practice of the bar and medical associations formed and controlled within these professions.

In view of the fact that an engineer may be capable of doing good work and yet, for dishonest or other reasons, he may elect to do otherwise, is it not clear that the place for the law to apply its tests and restrictions is not to what he is capable of doing, but to the physical features of what he does, or proposes to do?

It is not practicable to specify by law a standard of how legal advice shall be given or how a surgeon shall operate, but it is perfectly feasible to fix by law a standard of strength in bridges and buildings—in fact, this is quite generally done—and equally feasible to specify the essentials of a hygienic water-supply or sewerage system. The law also covers, more or less effectively, the conditions of railroads, vessels, mines, tunnels, boilers, electrical equipment and a great variety of other engineering works bearing on public health and safety.

Suppose this system of control or regulation were replaced by one which dealt only with the mental capacity of the engineers, can any one imagine that a greater degree of health and safety to the public would be secured? Suppose it were attempted to establish a system of capacity supervision and control, while still maintaining the present well advanced supervision and control over physical conditions, would there not be a disastrous division of responsibility? Would not the public safety and health be likely to fall between two stools? Would not efforts to secure practical results along physical lines be relaxed as a result of an illogical effort to secure the same result along different and more intangible lines?

A point which should perhaps be emphasized somewhat further is that the movement to secure a licensing law for engineers in New York is not based on any desire to benefit the public, but on a mistaken idea that in some mysterious way such a license law as is proposed by the McGrath bill will furnish means for improving the compensation of certain classes of engineers. While this is "a consummation most devoutly to be wished," and to which no intelligent engineer will offer opposition, evidence that a licensing bill will bring this about is utterly lacking, as is also the justification for letting the movement masquerade as a measure for the general public welfare, by purporting to prevent or reduce malpractice in engineering.

R. S. Buck, M. Am. Soc. C. E.

52 William St., New York City, March 20, 1911.

How Illinois Engineers are Affected by the Existing State Law Requiring Architects to be Licensed: An Investigation Suggested.

Sir: Referring to the recent discussion in the technical press and among engineering societies in regard to the licensing of engineers, we would like to contribute a word as to the situation existing in Illinois, and which doubtless exists in other states.

About 14 years ago the architects secured the passage of an architectural license law in which an architect was defined as "any person who shall be engaged in the planning . . . of buildings for others and to be constructed by other persons than himself," and a building is defined as "any structure having foundations, walls and roof, with or without other parts." It was necessary under the constitution to admit to practice all persons practicing architecture at the time of the passage of the law but it was provided that all future applicants for license should be examined by a board of architects to be appointed by the Governor.

This law leaves the engineering profession high and dry, except to provide that a civil engineer who plans and supervises buildings shall be regarded as an architect. This compels the engineer to carry on an important part of his work under the name of another profession, if indeed he is fortunate enough to pass an "architectural" examination, very proper for an architect in general practice, but wholly beside the point if required of a person designing engineering structures.

The Western Society of Engineers, through its Legislative Committee, has taken up this question of the legal disability of engineers in a very active way. It was attempted to find some way to amend the present law in order to give immediate relief to our profession, and a number of joint meetings were held between our committee and a similar committee from the Chicago Architects' Business Association.

It was decided that there were no practical methods for affording immediate relief, but the committee agreed unanimously that legislation should be sought for the following purposes:

(1) To entitle structural or building engineers to make plans for and supervise engineering structures which were defined tentatively as follows:

Structures of a strictly engineering character such as boiler houses; structures designed solely for the generation of electricity or for screening, storing or sizing coal, cement, sand, gravel, metals or similar materials; blast furnaces; rolling mills; gas producers and receivers; foundries solely for casting metal; smelters and similar plants where the support or housing of heavy machinery is the principal consideration.

(2) That certain kinds of buildings to be designed by architects, such as high office buildings and buildings with difficult foundations, should require the services of an engineer unless the architect should be also licensed as an engineer.

(3) That these classifications should be established by law, and structural or building engineers should be licensed in order to bring them under state control.

The situation in Illinois is somewhat different from the situation existing in states where no architects' law exists. We have no desire to attack or attempt to repeal the architects' license law, as we believe that it gives the public a certain measure of needed protection. We feel that public safety is our first duty, and since a structural engineers' license is a condition precedent to any enabling legislation, we believe that such a law in Illinois is not only logical but necessary, and we believe that the engineering profession should accept it as an important step in advance.

As to the best method of securing these results, it was decided by the committee to have a bill introduced at the present session of the Legislature providing for the appointment of a commission of engineers and architects to codify the state building law, and to recommend suitable legislation to the next Legislature to carry out their finding. This bill was introduced on March 3, by Senator Olsen, as Senate Bill No. 332.

Such a commission should be able to consider the entire question in a broad, constructive way, to define and classify engineering structures, to decide which classes of buildings should be planned by engineers, and which other classes of buildings should require their cooperation. We feel that engineers can well afford to wait a year or two for the sake of having the question settled right.

We also feel that the architectural and engineering professions should work hand in hand to this end. There have been no important differences of opinion on our committee, and the architects have shown the greatest desire to consider the whole question in a fair and broad way. We believe that real results can be secured by such cooperation.

Now as to the situation in states where no architects' license law exists. The architects have had bills similar to the Illinois law introduced in many legislatures, and it seems to us that the engineers residing within these states, or the local and general engineering societies, should continue to oppose the passage of such laws. Then let us do generally what we are now doing in Illinois, "get together" with the architects and draw up such laws as will effectively protect the public everywhere from incompetent designing and flimsy construction, and will regulate the sister professions of architecture and engineering in the interest of the public and of the standing and dignity of both professions.

Andrews Allen, Chairman; John Brunner, F. E. Davidson, Edgar D. Martin, W. C. Armstrong, Legislative Committee, Western Society of Engineers.

Chicago, Ill., March 17, 1911.

[We are asked to point out that this is not a movement for the licensing of engineers but for rectifying laws which at present adversely affect the practice of engineers in regard to building construction in Illinois. The committee invites the cooperation of engineers therefore in supporting the bill mentioned.—Ed.]

Notes and Queries.

Mr. Ernest McCullough, M. Am. Soc. C. E., of Chicago, Ill., referring to the recent discussion of trade catalog sizes, thinks that the most practical size for nearly all the printed matter now sent to engineers is 8½ × 11 ins. or 8 × 10½ ins. For the smaller sizes he recommends 3¼ × 6 ins., and 6 × 9 ins. for all catalogs which are ½-in. thick or over. These sizes are recommended the largest because it is the most convenient for vertical filing cabinets, the intermediate size fits a standard book shelf, and the smallest size will fit into an ordinary business size envelope.

Correction.—In the letter by Mr. James S. Mallon on quick-dumping cars in our issue of March 2, the sentence in the 15th line on p. 267 should read: "The troubles with the doors, therefore, should not be classed as failures." The typographical error in the omission of the word "not" reverses the proper meaning, but this will be apparent to any one reading the preceding sentence.

Mr. J. A. Holmes, of Cambridge, Mass., informs us of an oversight in his article on "Arresting the Flow of a Large Tidal River; the Charles River Dam," published in Eng. News, March 9, 1911. He inadvertently neglected to give credit for the final design of the shut-off dam to Mr. Geo. B. Francis, M. Am. Soc. C. E., Consulting Engineer, of 10 Bridge St., New York City. Mr. Francis adopted portions of the original scheme with additional features suggested by Mr. Hiram A. Miller, Chief Engineer of the dam, and Mr. James W. Rollins, Jr., the contractor. Mr. Francis himself contributed the most important improvements, in the substitution of sliding gates for the separate stop-planks of the original plan. By means of these gates, the flow of the river was arrested in a few seconds, a feat that could not have been accomplished with the separate stop-planks.

The Typhoid Epidemic in Ottawa Canada.

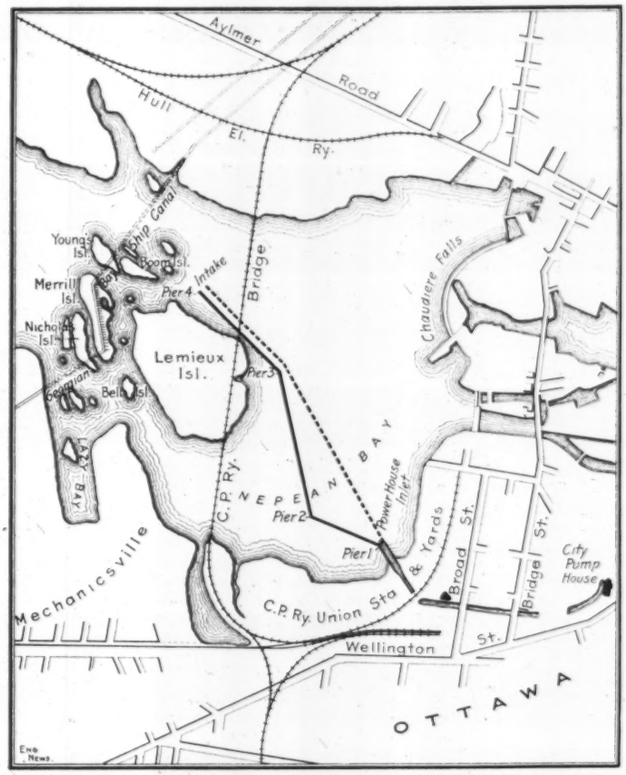
By P. H. BRYCE,* M. A., M. D.

Seldom indeed has an outbreak of typhoid had a more sharply defined beginning, a more definite course or, let us hope, a more natural termination, than that which marked the recent epidemic outburst in Ottawa in the third week of January, 1911. In order that the distinctive features of the outbreak may be studied with the elements entering into its causation, reference must be made to the accompanying sketch map of the district.

The epidemic has many of the features common to the outbreak in the late autumn of 1887 which the writer then officially investigated, and which proved to be directly related to the fact that in the raceway from Nepean Bay which fed the water wheels for pumping at the chute below, was laid a clear-water intake pipe from the point on the map somewhat beyond that in the bay marked Power Inlet, and which is the point known now as Pier No. 1, the place at which there is an emergency valve on the steel pipe, the opening of which for some five hours during a serious fire on Jan. 4, 1911, is coincident with a period some ten days before cases of typhoid appeared in such numbers as to forecast the present epidemic. All sorts of theories existed in 1887 as to the cause of the epidemic, the older generation of physicians insisting that the waters of the mighty Ottawa could not be the cause. The general distribution of 2,000 cases then precluded, however, any other explanation, and in the spring tests made showed the wooden pipe of the aqueduct to have great strips torn from it by the ice and that, with the inlet closed, water still flowed from the full pipe into the pump well. Local sewers discharged into the raceway, and typhoid in houses along these was thus proved to be an adequate explanation of the outbreak. A curious coincidence in the present outbreak is found in the fact that a second raceway and clear-water pipe are at present being built alongside the old one. In constructing the raceway one or more short sewers have been cut across and for convenience the contractor pumped the sewage therefrom into the old raceway over the water pipe. Much interest hence attaches to this sewage discharge as a possible factor in the causation of the outbreak.

*Chief Medical Officer, Department of the Interior, Ottawa, Canada, formerly Secretary, Ontario Provincial Board of Health.

When, in 1888, the new steel pipe was laid, it was extended to Pier No. 1, where the inlet remained until it was extended to the deep-water channel about 1900, as seen on the map, where there is a depth of some 20 ft. as the water rushes past to plunge over the Chaudiere Falls. The mouth of this intake is some 16 ft. beneath the surface; but from Pier No. 1 to this point, Pier No. 4, the course of the pipe is over the uneven limestone floor of the river. The pipe is about 40 ins. in diameter and has to deliver an ordinary daily supply to the pumps of some 16,000,000 imp. gals. This is quite possible for it, but any great extra work is impossible except in high water, since the large mill powers on either side of the river draw the water down to a level, which is only some 2 ft. over the top of the steel pipe at its highest point; the hydrostatic pressure in the pipe thus being regulated by mill-owners quite independent of the city of Ottawa, since the river is in inter-provincial stream, and further is navigable, and hence under federal control. In years long past rights of riparian ownership were granted to some of the mill companies. During the long and severe winter the water flow becomes as low, probably lower, than even in the later summer, as the small streams and lakes of the immense water shed (34,000 sq. mi.) are frozen and largely cease flowing. It will thus be seen that while the city engineer has under construction a new water main to the deep channel to be laid to grade in a deep blasted cut, he has in the meantime to depend either upon the water level supplied him or in any emergency upon the opening of the valve at Pier No. 1. During low water, as in winter, the city engineer has had a man stationed continuously at Pier No. 1 with telephone connection to the pump-house, who, when the fire bell rings, and the water in the well begins to fall, is ordered to open the valve.



SKETCH MAP SHOWING THE POSSIBLE RELATION OF THE WATER-SUPPLY OF OTTAWA, ONT., TO THE TYPHOID EPIDEMIC IN THAT CITY.

(Prepared by Mr. Caushon, of Caushon & Haycock, Consulting Engineers, Ottawa; based on Georgian Bay Canal Report of 1908.)

With this statement made, we may now ask, what caused the epidemic? The river widens above the seven miles of rapids into Lac Deschenes, a great settling basin having an average width of two miles and a length of 27 miles to the great Chats Falls above. Mr. Allen Hazen has estimated that in low water, as in winter, the upper waters will remain some two weeks in this natural settling basin. On the south shore, from the city to the lake, are some summer cottages, a club-house and Cave Creek, which, before entering the river flows through a suburb of Ottawa; and on the north bank there is a permanent town, Aylmer, with some 2,500 population, which some two years ago, introduced into the lake the outlet of its main sewer. This town is some nine miles above the intake. Its influence with the sewage from it tending shoreward along a shallow sandy shore, thus sedimenting in part, has not been noticed to have increased the chlorine in the water taken at the intake, it having stood in tests during 18 months almost steadily at from 1.5 to 2 parts per 1,000,000, while regular bacterial tests for the same period, although showing in three separate tests in August, 1909, B. coli in each of 3 samples taken at the same time, failed to show in a total of 73 samples taken during the next 15 months B. coli in 1 cc. of water in any three samples taken at one time. Not only so, but not on one occasion again did even two samples show B. coli, and only on 20 occasions did one of the three samples give B. coli; while there were over 53 occasions with no B. coli whatever present in 1 cc. of water. The three last samples taken before the outbreak, namely, on Nov. 22, Dec. 8 and 15 (1910), respectively, gave at the house tap and health office tap no B. coli in any of the four samples.

Such was the situation up to January, 1911; while judged by a yet better test it is shown that the typhoid cases reported to the Health Office from Nov. 1, 1909, to Oct. 31, 1910, numbered only 67, of which 47 were treated in their homes and 20 in the hospital. Of the whole, 34 came from definitely named outside places, for the most part, while of the balance no definite history was given. It is hardly necessary to say that of 33 cases distributed over 12 months, no causal relationship with so slightly polluted a water-supply can be inferred. It may be mentioned that only four typhoid cases occurred in December, 1910, while compared with these figures we find 900 cases probably to have occurred within two months of a sudden, definite and notable change in the conditions of the supply. It is not, however, necessary to assume the absence at any time of pollution from Aylmer during the 18 months since daily examinations during the past month have shown B. Coli present always in 10 cc. of raw water from the intake pipe, but the total bacteria had on no day risen to 100 per cc.

Hence as regards the cause of the outbreak we are apparently forced to one of two alternative conclusions; one based upon the ascertained facts that the emergency valve at Pier No. 1 in Nepean Bay was opened for some five hours on Jan. 4, 1911, and that pumps, worked at a high rate of speed, to pour water upon a burning storehouse of methylated spirits, brought in polluted water from the Bay, or the other based purely upon an assumption that from the raceway, through some leak in the aqueduct-sewage from the water of the raceway gained entrance to the pipe through suction during the great fire. In reply to the latter suggestion, the engineer states that after repeated examinations by a diver, he has failed to find such leak; while the further question arises, could suction possibly, even though a leak were present, take place while the inward flow from the valve was sufficient to keep the pumps supplied with water during five hours hard pumping? While Nepean Bay is undoubtedly the receptacle of refuse from the great log booms and the men working on them in the summer and from Cave Creek in summer, and while it is fairly certain that a small amount of Aylmer sewage may flow into the Bay, yet it must be remembered that for six weeks Cave Creek had been frozen and that from the Bay where it empties, a mile from Pier No. 1, the people of Mechanicsville have been hauling water in barrels all winter and have no typhoid. Was there, then, such a deposit of the recent Bacillus Typhosus in any debris at Pier No. 1. as that the suction of it into the pipes on Jan. 4 was adequate to cause the outbreak, or must we assume, in order to explain it, that fresh raw sewage by suction obtained admission to the pipes at the same time? The problem is one for engineers to solve.

Within a short time after the epidemic was in full swing, the calcium hypochlorite treatment was introduced at a point where the water from the intake and that from the emergency valve could both be treated, while daily analyses of the raw water, that from the city hall tap and from a house tap on a side street have been made. These are interesting as showing that B. Coli were regularly present in 10 cc. of raw water, while less than 100 bacteria were present; further, that city hall samples continued to show from 4 to 6 B. Coli in 10 cc. for several weeks after the treatment began, but that water from a tap in a side street was negative after the first three weeks. It has been therefore a fair assumption that since the hypochlorite treatment is immediate and at the point of application and not continuous throughout the pipes; that since the B. Coli found at the city hall tap shows that the gross pollution supposed to have taken place at the time of the fire through the valve was gradually deposited as sediment in the pipes, that the larger service pipes have had these deposits disturbed daily, thereby having some B. Coli given off but in daily decreasing amounts, and that the slight disturbance caused in the deposits in lateral pipes through drawing water off at house taps is insufficient to disturb the sediment in these.

The epidemic is slowly declining, due, it is assumed, to the fact that the B. Typhosus in the mains have lost their vitality while the daily amount of sediment has regularly decreased. Remembering that it is now over two months since Jan. 4, it would seem that either many of the cases being reported daily at present were infected weeks ago, or that we must review our belief in Dr. Houston's experiments on raw Thames water inoculated with typhoid and kept in the dark in the laboratory, wherein 99.9% died within a week, as being applicable to the present case where similar germs are carried into a pipe along with quantities of organic matter wherein they sediment but apparently live on for much longer periods due to the nutriment provided by the organic deposits.

THE BEHAVIOR OF IRON EMBEDDED IN CONcrete for a long period was recently noted in the examination of a portion of the reinforcement of a concrete building erected in Paris by Mr. Francis Coignet in 1852. This is a 3-story building, the roof of which is a reinforced-concrete slab some 12 ins. thick with a minimum span of 20 ft. The concrete is said to be a mixture of cement gravel and lime in the proportions of 1½:1:5, with very small gravel, probably all below ½-in. in size. The reinforcement consists of small I-beams, about 3¼ ins. deep, placed at the under side of the beam. About 13 years ago, a hole was made in the top of one of these roof beams and the concrete removed clear down to the iron, which was found to be clean and free from rust. This hole was then filled with fresh concrete. Quite recently this 13-year-old concrete was removed and the iron again examined and again found to be in perfectly good condition. This second examination was made in the presence of a deputation from the Concrete Institute, of London.

A 300,000-lb. Track Scale With Relieving Gear and Adjustable Hump.

The distinguishing features of the new track scale recently built and put into use by the Pennsylvania R. R. Co. at West Brownsville Junction, Pa., are three: The relieving gear, by which the use of a dead rail is avoided; the adjustable hump whereby the speed of cars passing over the scale can be adjusted to the most convenient value which is between them and the scale. The mechanical hump and the scale itself are erected in a single concrete-walled pit about 100 ft. long.

The dimensions of the pit walls and foundations are shown in Fig. 2. The length of the scale alone is 52 ft. and it rests on a continuous concrete slab 4 ft. thick which forms the floor of the scale pit. The floor of the hump pit is only 1 ft. thick except at the ends and middle, where it has a thickness of 4 ft. under the hump's

FIG. 1. GENERAL VIEW OF TRACK SCALE AND SCALE HOUSE AT WEST BROWNSVILLE JUNCTION, PA.

and maintained under varying weather conditions; and the large capacity, 300,000 lbs.

This capacity is much in excess of the gross weight of the heaviest loaded freight car, and in all probability the scale will rarely be taxed to even two-thirds of the full capacity. The reserve capacity, however, is expected to be of use indirectly in maintaining the scale's life and accuracy. The unit loads on the knife-edges will be lower and thus the rate of wear will be reduced, and the smaller deflections under ordinary loads will conduce to greater accuracy. Then, too, since the usual dead-rail construction is replaced by a relieving gear, the platform, or bridge, supporting the scale rails must be, like the foundations, strong enough to permit the passage of locomotives, even though it is not desired to weigh them. Thus the only thing necessary to secure the advantages of the higher scale capacity was to give sufficient strength to the lever system.

A general view of the scale and scale house is shown in Fig. 1. The scale beam is at the mid-length of the scale platform and is enclosed in the bay-window of the house. The cars shown are on the approach to the adjustable hump piers. The scale pit is 9 ft. wide and 6 ft. deep below the base of the rails. Its walls are about 2½ ft. thick. The pit under the hump is narrowed to a width of 7½ ft. and the wall thickness is also less than in the scale pit. A bay at the mid-length of the scale pit extends under the bay-window of the scale house and contains the fifth lever and the connections to the scale beam. Concrete abutments at each end of the pit are extended under the adjoining track rails for a distance of 8 ft. beyond the end walls. This prevents the settling of the track at the point where the cars come onto the hump and where they leave the scale.

Scale.

The scale is of the four-section type with four points of support under each rail of the scale track. The lever system can be understood from Figs. 2 and 3. The points of support for the platform are at the knife-edges of eight short transverse levers. These levers, arranged in pairs, pass the load on to four longer, longitudinal levers. The two longitudinal levers at the ends of the scale transmit their share of the load to the two middle levers, which receive also the load from the four central transverse levers. The central longitudinal levers mutually transmit the combined load to the short arm of the fifth lever, which is connected by a vertical rod to the shelf lever just below the scale beam.

The reduction ratio of the transverse levers is 5 to 1, and that of the longitudinal levers is 8⅓ to 1. The central longitudinal levers are so arranged, as shown in Fig. 2, that the load from the end levers is simply transmitted through them without reduction, while at the same time they reduce the load from their own transverse levers in the same ratio as do the end levers. Consequently the total weight of a car on the scale is transmitted with a reduction of 41⅔ to 1 to the fifth lever. The fifth lever gives a further reduction of 3 3-5 to 1, the shelf lever 5 to 1 and the beam itself 16 to 1. Thus the total reduction is 12,000 to 1, and a 25-lb. sliding poise is required on the scale beam.

The beam is graduated in thousands of pounds from zero to 300,000. In addition the poise carries a short graduated scale with a sliding rider by means of which the weight can be read to within 10 lbs.

The full capacity load on each one of the eight main points of support is 300,000 ÷ 8 or 37,500 lbs. This is taken on knife-edges about 9 ins. long, giving a load of about 4,000 lbs. per linear inch. Not only these main knife-edges but the others throughout the scale are designed for this intensity of loading, which is much less than that usually found in track-scales. In some of the older scales and in testing machines of the scale type, the maximum loading was 10,000 lbs. or more per inch of knife-edge. The same generous plan of design is followed out in the proportions of the levers, which are designed to safely carry the full load with an allowance of 100% for impact. We are informed that the sensibility of the scale has not been materially affected by the increased weight of the levers and length of knife-edge contacts.

The rails of the scale track are supported by planed hardwood ties bolted directly to two 24-in. I-beams. These I-beams, tied together by channels spaced about 13 ft. apart, form a bridge over the scale pit. This bridge is shown in position in Fig. 4, and in Fig. 5 the track is shown in place on the bridge. The rails do not rest directly on the ties but are fastened by rail clips to square cast-iron columns about 9 ins. high. This construction is shown in Fig. 6. The cast-iron columns project up through the platform floor or deck, which is independently supported by joists spaced between the ties. The ends of the joists rest on the steps shown near the top of the concrete walls of the pit in Figs. 3-5. The platform deck is shown in place in Fig. 7. With this construction, wind pressure or snow and ice on the platform does not affect the empty balance of the scale.

The I-beams of the bridge are supported on the knife-edges of the main (transverse) levers by suspension bearings which permit small lateral or transverse oscillations of the bridge without excessive friction or wear on the knife-edges. The construction of one of these bearings is shown in Fig. 6. A yoke casting is bolted to the lower flange of the I-beam and encircles the main lever at the point where its supporting knife-edge is situated. On the knife-edge rides a sad-

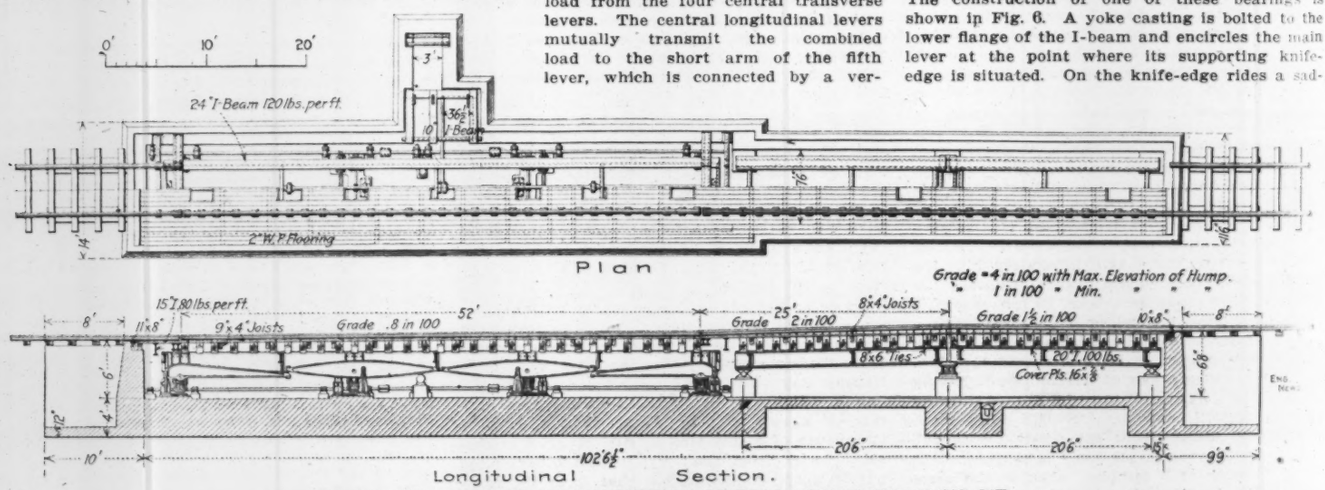


FIG. 2. PLAN AND SECTIONAL ELEVATION OF TRACK SCALE AND HUMP PIT.
(The height of hump is adjusted by means of jacks below the saddle castings supporting the summit.)

Fig. 3. Scale Pit With Lever System and Relieving Gear Installed.

Fig. 4. I-Beam Bridge for Scale Track in Position on the Knife-Edges.

Fig. 5. Scale Tracks in Place on the Scale Bridge; Platform Floor Not Yet Laid.

FIGS. 3, 4 AND 5. THREE STEPS IN THE CONSTRUCTION OF THE WEST BROWNSVILLE JUNCTION TRACK SCALE.

die block with an inserted steel bearing piece. Two links are suspended from the ends of the saddle block and engage at their lower ends with nose-shaped hooks projecting from the yoke casting. The point of support is placed beyond the end of the scale track so as to eliminate overhang at the ends of the scale and thus prevent tipping.

It can be seen in Fig. 6 that the steel bearing piece of the saddle block is curved on its upper edge where it is seated in the block, so that by sliding slightly in its groove it can compensate for any longitudinal oscillation of the block and maintain a full-length bearing on the knife-edge. The fulcrum knife-edge at the end of the short arm of the main lever bears on similar compensating steels seated in the lever-stand casting. Compensating steels are fitted also to the stands supporting the longitudinal extension levers. A special vanadium steel is used.

Spots to which a spirit level can be applied are machined at convenient points on each lever. These leveling pads are so placed that the level, when applied to them, is in line with the neutral axis of the lever. Means of adjustment are provided at the connections between lever ends so that with the help of the leveling pads the levers can be set with their neutral axes horizontal. Plans have been made for heating the scale vault by a hot-water circulating system, and electric lights are to be installed for use when the scale is being inspected.

Relieving Gear.

The relieving gear consists of eight toggle-lever jacks operated in unison by a double-acting compressed-air cylinder. The cylinder can be seen in Fig. 3, mounted at the middle of the scale pit near the fifth lever. Its operation is controlled by the weigh-master through a valve mounted on the shelf below the scale beam. This valve with its connecting pipes can be seen in Fig. 5. Hand-operated mechanism is provided for use in case the supply of compressed air is interrupted.

The piston rod of the air cylinder operates a crank secured to the torsion shaft shown in Fig. 3 extending along the right-hand side of the pit close to the concrete floor. This shaft has also four other cranks which transmit the motion to tension bars at right angles to the shaft. These bars operate the toggle levers of the jacks. The jacks are mounted in pairs on the same base-plates that support the lever stands. The vertical plungers act directly against the lower flanges of the I-beams of the scale bridge at points close to the suspension yokes. By reference to Fig. 6, it can be understood that the operation of the relieving gear does not disturb the alinement of any part of the scale mechanism. Even the contact of the knife-edges at the main suspension bearings remains undisturbed, although the platform or bridge is raised enough to relieve them of all imposed pressure.

The torsion shaft is indirectly connected to a semaphore arm at the end of the scale, so that this arm indicates whether the scale is set for weighing or for the passage of locomotives and "not-to-be-weighed" cars. The relieving gear is not designed to operate with a superimposed load on the scale. But with 80 lbs. per sq. in. air pressure in the cylinder, the weight of the bridge or platform alone (about 38,000 lbs.) can be lifted on the jacks in about one second. The ordinary interval between cuts of cars passing over the scale is 18 or 20 seconds, so that no pause in the regular operation is needed for working the relieving gear.

The Adjustable Hump.

One of the earliest track scales served by a gravity track or hump, described in Engineering News of Sept. 21, 1899, p. 186, was erected in the yard of the Chicago, Lake Shore & Eastern Ry. at the Illinois and Indiana state line. In the case of gravity classification yards, it is now standard practice, when most of the cars handled over the hump are to be weighed, to erect track scales on the delivery slope of the hump at a distance of 100 ft. or less from the summit. The length of scale and the distance from summit of hump to scale platform have steadily decreased, in the best practice, as more experience was gained in hump-scale operation. In the present case, the distance from the hump summit to the nearest end of the scale is only 25 ft.

The cars to be weighed are uncoupled on the

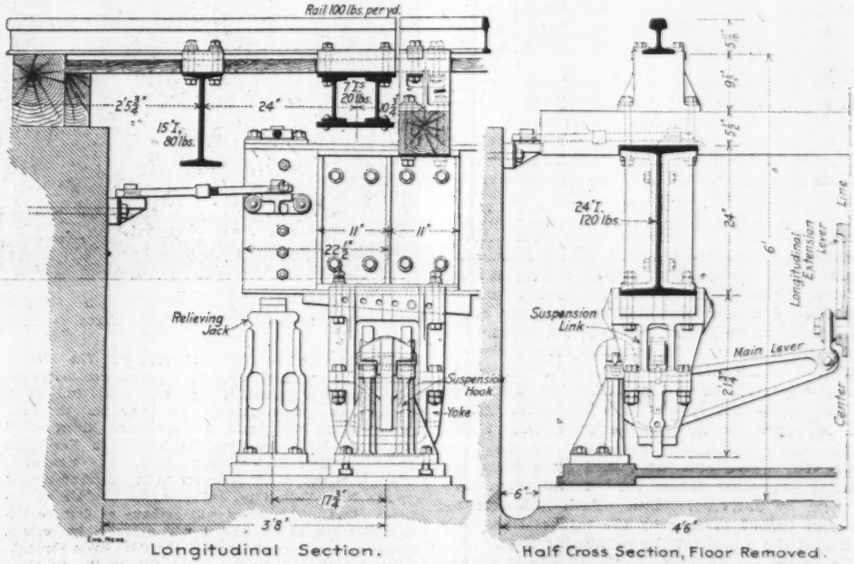


FIG. 6. DETAILS OF CONSTRUCTION AT ONE OF THE EIGHT MAIN POINTS OF SUPPORT, SHOWING SUSPENSION BEARING.

way to the hump and are pushed slowly over the summit so that each car, as it begins the descent on the further side, forges ahead of the one following. Thus they reach the scale sufficiently separated for accurate weighing. With the scale close to the hump summit, the velocity of the cars as they cross the scale is small. This permits the use of a short scale platform (100 ft. was formerly not an uncommon length, while the present scale is 52 ft. long), and the combination of short scale and low velocity permits the cars to be closely spaced. This gives at the same time both accurate weighing, and as regards cars weighed per hour, rapid weighing with a minimum of wear and tear on the scale.

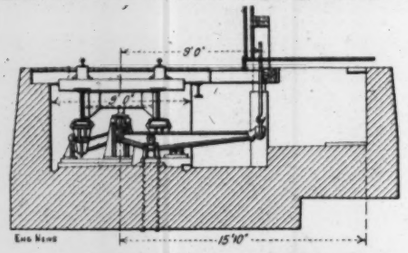


Fig. 7. Transverse Section Through Scale Pit.

The distance from hump summit to scale (25 ft.) is here made about equal to the distance between centers of trucks of the cars having the shortest ordinary wheel-base. With this arrangement, the velocity of the cars over the scale is about inversely proportional to the length of the wheel-base. A car with a long wheel-base will have its front truck on the scale before the rear truck mounts the summit of the hump, and thus its speed while crossing the scale will not be so great as that of a shorter car. This is a desirable condition, for the longer car, if moving at the same speed as the shorter, would have both its trucks on the scale for a shorter interval of time. With the 25 ft. spacing of scale and hump, the time interval for weighing is approximately equalized for cars of different lengths.

Considerable inconvenience has been experienced with classification humps due to the variance of car resistance with the seasons. In winter the acceleration given by the hump is appreciably less than in summer, due largely to the effect of lower temperature in tightening up the running gear and thickening the lubricant. In some cases it was even found profitable to rebuild the hump with the change of seasons. The adjustable summit of the hump at West Brownsville Junction is a feature intended to give convenient and effective means of maintaining constant car velocity over the scale in spite of seasonal variations in car resistance. So far as is known, this is the first installation to provide mechanical means for adjusting the height of the hump.

The general plan of construction of the hump is clearly indicated in Fig. 2. The adjustable portion consists of box girders supported on piers in the hump pit. Each rail is supported over the pit by one of the girders, which instead of being continuous from end to end of the pit, are divided in two at a point above the middle pier. The girders rest at this point on heavy steel castings which support them at an elevation some inches above that of the end piers, so that the summit of the hump is definitely located at the point of division of the girders. A hand-operated jack is provided by means of which the castings supporting the summit can be raised or lowered.

The construction at the middle piers is shown in Fig. 8. Each pier has a gap in the middle in which is located the lifting jack. The jacks are of the toggle-lever type with a horizontal right-and-left screw for drawing the lower ends of the toggle arms together. The screws of the two jacks are in line and are joined by a piece of shafting extending across the pit and connected to them by universal joints. Both jack screws are thus turned at once by the ratchet lever attached at the middle of the connecting shaft.

The jacks act directly on the saddle castings which bridge the gap in the piers and support the girders. In the lowest position, the saddle castings rest on base-plates on top of the piers. After being jacked to a higher position, their ends are blocked up by inserting distance pieces between them and the base-plates. Then the jacks are released. This gives a firm support to the summit and relieves the jacks from all strain except when they are actually in use for raising or lowering. The maximum lift provided for is about 8 ins.

At the end piers, the hump girders are supported by journal bearings which allow them to assume the different angles corresponding to changes in the height of the summit. The pedestals supporting these bearings are arranged to slide longitudinally on their base-plates to allow free movement of the girders when the hump is being raised or lowered and during expansion or contraction due to change of temperature.

This type of construction, both of scale and hump, has been adopted as standard by the Pennsylvania R. R. The chief features of the design are covered by patents taken out by Mr. A. W. Epright, scale inspector of that road.

Opinion and Decision in the New York Harbor Line Case.

The applications to the War Department for pier extension along the Hudson River at New York City, reviewed somewhat fully in our issue of March 9, 1911, resulted (as there stated) in a decision by the War Department to permit no permanent extensions but to authorize a temporary extension of two piers by 100 ft. each as a protection for the new 882-ft. White Star ships. The decision bases directly on an opinion given by Chief of Engineers W. H. Bixby upon the report of the New York Harbor Line Board. This opinion summarizes the case in concise manner, and we are glad to be able to quote its essential parts.

Gen. Bixby says:

The localities affected by the changes requested by the International Mercantile Marine Co. and the Riparian Commission of New Jersey are on opposite sides of the North (Hudson) River at its narrowest part along the Jersey City and New York City frontage. The effect of granting the requests would be a permanent narrowing of the narrowest portion of the river by 200 ft., 100 ft. on each side. It is through this gorge that the flood tide enters the tidal basin of the Hudson River, which extends for 153 miles from the Battery in New York City to the State Dam at Troy, N. Y. Any diminution of the cross-section of the river at its narrowest point opposite New York City will probably produce an injurious effect. This effect will perhaps at first be imperceptible but in the end it will probably be serious, causing eventually a shoaling of the tidal basin throughout its length and leading eventually to the necessity of dredging along harbor fronts, etc., in many parts of the basin and in portions of the 28 miles of channel near Albany now already requiring improvement. [illegible] in the dull season of the year over a hundred [illegible] have been seen to pass up or down the river past the [illegible] in question in a single hour, and a diminution [illegible] way will increase the danger of collisions and [illegible] increase the delays to river traffic.

Since the first establishment of harbor lines [illegible] this part of the Hudson River by the New York Harbor Commissioners, there has been a progressive movement of the harbor lines out into the stream until the narrowest section of the river in this neighborhood, which in 1857 was 3,200 ft. at 14th St., has since been reduced to 2,730 ft. in width at 23d St. Each movement of the lines out into the stream was apparently urged on the ground that the movement was necessary in an emergency and that further movement would be unnecessary in the future. Since 1897 the New York Harbor Line Board has steadfastly opposed any further outward movement of the harbor lines and consequent diminution of the fairway of the river, and in 1903, 1904, 1908 and 1910 applications for such changes of the harbor lines were denied by the Secretary of War.

The principal reason urged for the advancement of the harbor lines at this section at present is that boats of 882 ft. length are expected to arrive in New York Harbor during the present summer, that there are at present no docks sufficiently long to accommodate them, and that the extension of the Chelsea piers is the only practicable method of making proper provision for these boats by the time of their arrival. With regard to this the Harbor Line Board states:

The contention that the new steamers cannot be taken care of anywhere except at the Chelsea piers does not seem warranted when it is considered that the piers at the Bush Terminal in South Brooklyn, those at Staten Island, and those at Manhattan Island north of 40th St., could certainly be made available for temporary use in four months' time. The convenience of passengers would be amply met at the piers referred to on Manhattan Island. . . . While these places are herein referred to as possible sites for temporary berths, it is not the province of this Board to suggest the solution of the problem for the best use of the water front of New York Harbor, but there appears to be no reason to doubt that the authorities entrusted with that duty can and will solve it satisfactorily without encroaching further on the navigable waters of this great harbor.

I concur in the findings and recommendations of the New York Harbor Line Board and recommend that the applications of the International Mercantile Marine Co. and the Riparian Commission of New Jersey for permanent changes, be denied; that the Department of Docks of the City of New York be notified that its present application for changes in harbor lines is not favorably considered; and that the requests of the Cunard Steamship Company and the Compagnie Generale Transatlantique for pier extensions made direct to the Board be denied.

In view, however, of the urgent needs of the International Mercantile Marine Company for temporary facilities, I recommend that when said company is notified that their application for permanent extension of piers is denied to them, they be also informed that upon receipt of plans recommended by the Chief of Engineers (as required by section 10 of the act of March 3, 1899) authority will be given to them by the Secretary of War by usual War Department permit to construct and maintain for not exceeding 18 months a temporary extension to each of two piers of one of the Chelsea district slips, with the understanding that the extension sha[illegible]

FIG. 8. SUPPORTING CASTINGS AND ELEVATING JACKS AT SUMMIT OF HUMP.
(The ends of the saddle castings are blocked up after being jacked to the desired height, thus relieving the jacks.)

be freely open to the passage of water below high water level; that the extensions shall not be decked nor roofed, and shall be so constructed as to be easily removable and only in accordance with detailed plans approved by the Chief of Engineers; and that one of the special conditions which will be imposed by the Department in approving the plans will be that the extension shall be promptly removed by the company upon notice from the Secretary of War and within the time specified therein and that if not so removed, it may be immediately removed by the War Department at the expense of the said company and without any further interference of any kind or any legal proceedings to prevent same, and that said company at the time of the issuance of said license shall enter into an obligation as above provided.

W. H. Bixby,
Chief of Engineers, U. S. Army.

Washington, March 8, 1911.

The opinion followed the public hearing held before Secretary-of-War Dickinson on March 6 (noted in our issue of March 9), and its final recommendation expresses the decision reached by the Secretary of War. The opinion above quoted was approved by the Department and action taken in accordance with the recommendations.

Notes from Engineering Schools.

UNIVERSITY OF UTAH.—The construction of a central building to be occupied by the main library, the administration offices and a general auditorium, has been recently authorized by the State Legislature and approved by the Governor. The intention is to obtain the space now used for these purposes in other buildings for much needed additions to the facilities of the school of mines. The authorized cost of the new building is $300,000.

A WALL LEFT STANDING AFTER A FIRE which had gutted a brick and stone store building at Nashville, Tenn., fell March 15 while workmen were engaged in salvage work. Thirteen men were killed and 17 others were injured. The accident is ascribed to high winds.

DYNAMITERS wrecked the unloading derrick of the Milwaukee Western Fuel Co., March 16, at Milwaukee, Wis. Five persons were injured. The property loss is placed at $150,000, including damages received by a coal boat. Reports state that non-union men were employed by the company that erected the crane.

An electric-railway bridge just south of Springfield, Ill., was dynamited March 9. One of the concrete piers was demolished.

A COAL MINE EXPLOSION March 19 killed five men at the mine of the Missouri, Kansas & Texas Ry., at Mineral, Kan. There were three separate explosions, the first of which killed two shot-firers who had just entered the mine. The second explosion followed closely upon the entrance into the mine of a third shot-firer bent on rescuing his fellow workers. He escaped alive, but a subsequent rescue party of three men was struck down by the third explosion.

BOILER, ELEVATOR AND FLY-WHEEL accidents in the United States and Canada, as noted in a bulletin published by the Fidelity & Casualty Co., of New York, caused the deaths of 45 persons during the month of January, 1911. The 35 boiler explosions of the month killed 22 persons. The worst single boiler accident was that on the U. S. Battleship "Delaware" Jan. 17, which killed 8 men. This accident was noted in Eng. News, Jan. 19 and March 2. There were 63 elevator accidents, in which 20 persons were killed. Of these 20, there were 7 killed by being crushed between car and shaft and 13 by falling down shafts. Fly-wheel accidents during the month numbered 18, including 4 grinding-wheel explosions, and killed three persons.

AN AUTOMOBILE FIRE ENGINE has been obtained for the Fire Department of New York City, and was first put into regular service March 20. During acceptance tests on March 16, the new engine attained a speed of 40 mi. per hr. over city streets, and in the pumping test, delivered between 750 and 800 gals. of water per min. at a pressure of 125 lbs. The speed guaranteed was 30 mi. per hr. and the capacity 700 gals. per min. The engine has a 110-HP. gasoline motor for propelling it and an entirely separate steam pumping engine of the usual type. Its weight is 16,000 lbs. It was built at Minneapolis, Minn., by the Nott Fire Engine Co.

A PUBLIC HEARING ON THE McGRATH BILL for licensing civil engineers in New York State was held at Albany on March 14, 1911, by the Assembly Committee on Public Education. It was attended by Judge Danaher, attorney for the Technical League, and W. G. Eliot, president of that organization, who appeared in favor of the bill, and by the following engineers who opposed the bill: E. A. Baldwin, Assoc. Am. Inst. E. E.; H. H. Barnes, M. Am. Soc. M. E.; A. P. Boller, Vice-Pres. Am. Soc. C. E.; J. C. Boyd, M. Am. Soc. C. E.; R. S. Buck, M. Am. Soc. C. E.; A. E. Cluett, M. Am. Soc. M. E.; E. B. Codwise, M. Am. Soc. C. E.; J. L. Dodge, M. Am. Soc. C. E.; G. B. Francis, M. Am. Soc. C. E.; W. W. Freeman, Assoc. Am. Inst. E. E.; A. M. Greene, M. Am. Soc. M. E.; O. H. Landreth, M. Am. Soc. C. E.; E. D. Meier, Pres. Am. Soc. M. E.; E. A. Merritt, Jr.; C. J. Parker, M. Am. Soc. C. E.; A. W. Pope; P. C. Ricketts, M. Am. Soc. C. E.; E. G. Spilsbury, M. Am. Soc. C. E.; F. J. Sprague, M. Am. Soc. C. E.; S. D. Sprong, M. Am. Inst. E. E.; C. W. Stone, M. Am. Soc. M. E.; A. H. Sutermeister, M. Am. Soc. C. E., and J. R. Taylor.

Judge Danaher suggested a number of amendments to the bill which would in effect confine the licensing to civil engineers engaged on public works only, not including mechanical, electric or hydraulic engineers.

The opponents of the bill were heard in the afternoon session. Several briefs were placed in the hands of the committee setting forth arguments against licensing in any form and calling attention to the impracticability of separating civil engineering from mechanical, electrical and hydraulic engineering.

Letters were read from the officers of Cornell, Columbia and Syracuse Universities opposing the bill on various grounds. Rensselaer Polytechnic Institute was represented by its President, P. C. Ricketts, and Prof. A. M. Greene, and also opposed the passage of the act.

AUTOMATIC REGULATION OF FUEL OIL for oil-fired boilers has been in use in the Redondo plant of the Pacific Light & Power Co. since 1908. According to the statement of Mr. A. C. Balch, general manager of the company named, the system of automatic regulation has given consistently satisfactory results under a widely varying power load. More economical use of fuel, evener distribution of load on the several boiler units, and closer regulation of the steam pressure are the chief advantages claimed over hand regulation.

A description of the Redondo plant was published in Engineering News Sept. 17, 1908, p. 302, and further notes on its operation in Engineering News, Nov. 25, 1909. The system of fuel-oil regulation used was developed by Charles C. Moore & Co., engineers, of San Francisco, Cal., and is now patented. It controls the supply of oil to all burners at once from a central point by regulating the fuel-oil pumps. The supply of air from combustion is also automatically regulated.

A similar installation is being installed for the Southern California Edison Co.

A STEAM-ELECTRIC DEVELOPMENT for long-distance transmission of electricity, generated at a colliery, is announced by the Lehigh Coal & Navigation Co., of Philadelphia, which owns coal mines near Mauch Chunk, Pa. This station will be erected at Hauto, about ten miles west of Mauch Chunk, and the smaller sizes of anthracite will be used with a portion of material that is now waste. The initial construction will be for 20,000 KW. but this will be increased to 100,000 as the business demands. At Hauto, there is an ample supply of water, of which 300,000,000 gals. per day will eventually be needed for boiler feed and condensation. An existing reservoir will be increased to have a storage capacity of 1,000,000,000 gals. The energy will be distributed through eastern Pennsylvania, particularly for the cement and slate regions. A schedule of prices has been fixed which ranges from 0.8 to 2.5 cts. per KW.-hr., depending on the quantity supplied to a customer. This is claimed to be materially under the cost of steam power here and yet high enough to yield a good profit. The transmission lines, it is reported, will be strung largely along the right-of-way of the Lehigh Canal and of the Lehigh & New England R. R.

LOWER EXPRESS RATES by "boat and rail" between New York City and certain New England points have been ordered by the Interstate Commerce Commission as the result of litigation conducted by Mr. Richard J. Donovan in conjunction with Mr. Henderson, of the National Claim Bureau, all of 170 Broadway, New York City. The reduction is from $1 to 75 cts. per 100 lbs., and smaller packages proportionately. It is stated that this is the first break in express rates thus far effected.

GAS-ENGINE VESSELS.—Recently, at Southshields, England, a 120-ft. vessel, equipped with internal-combustion engines, was launched. This boat has a 22-ft. beam and will carry something over 300 tons dead-weight on a draft of 10 ft., at a speed of 7½ knots. Two duplicate sets of high-speed, six-cylinder, vertical engines, made by Hindley & Sons, of Bourton, Dorset, will operate at 45 r. p. m., developing 180 B. HP. each. Gas will be supplied by an anthracite producer, and it is expected that 2,500 to 3,000 lbs. of coal will be consumed daily, compared with 7,800 lbs., which has been found to hold for similar vessels of equal power steam driven with compound engines.

A vessel is building in the yard of Barclay, Curle & Co., Glasgow, for the Russian-East Africa Co. This vessel is to have about 7,000 tons carrying capacity, with accommodations for passengers. A speed of 12 knots is designed to be secured with Diesel oil engines, driving twin screws.

Personals.

Mr. F. W. Hild, formerly Assistant General Manager and Chief Engineer of the Havana Electric Ry. Co., of Havana, Cuba, has been appointed General Manager of the Portland (Ore.) Railway, Light & Power Co.

Mr. Frank F. Sinks, M. Am. Soc. C. E., has retired from the firm of Condron & Sinks, Consulting Engineers, Chicago, Ill., to locate in Seattle, Wash. The Chicago office will be continued by Mr. T. L. Condron, M. Am. Soc. C. E.

Prof. W. F. Shaphorst, of the Department of Mechanical Engineering at the New Mexico College of Agriculture and Mechanic Arts, has resigned to accept a position on the staff of A. Eugene Michel, Advertising Engineer, New York City.

Mr. H. M. Hayward, Assistant Division Engineer of the Connellsville Division of the Baltimore & Ohio R. R., has been promoted to the position of Assistant to the Chief Engineer of Maintenance-of-Way of the Baltimore & Ohio Southwestern R. R., at Cincinnati, Ohio.

Mr. S. B. Wight, Purchasing Agent of the New York Central & Hudson River R. R., has been made General Purchasing Agent of the New York Central Lines. Mr. W. C. Bower, Chief Clerk in the office of the President, has been appointed Purchasing Agent to succeed Mr. Wight.

Mr. Andrews Allen, M. Am. Soc. C. E., formerly Contracting Engineer for the Wisconsin Bridge & Iron Co., has opened an office for private practice in the McCormick Building, Chicago, Ill. He has formed a partnership with Mr. John A. Garcia under the firm name of Allen & Garcia.

Mr. Charles A. Park has resigned as Civil Engineer and Superintendent of Construction, War Department, stationed at Fort Russell, Wyo., to become Superintendent, in the U. S. Lighthouse Service, at Detroit, Mich., of the 11th District, comprising the coasts of Lake Huron and Lake Superior.

Messrs. H. P. Mobberly, Assoc. M. Am. Soc. C. E., formerly Chief Engineer of the Paris & Mt. Pleasant R. R., at Paris, Tex., and W. A. Burton, have opened an office in the Woodruff Bldg., Springfield, Mo., under the firm name of Mobberly & Burton, for the general practice of engineering.

Mr. Luther H. Burt, Assoc. M. Am. Soc. C. E., has resigned as Assistant Engineer of the Bronx Valley Sewer Commission at White Plains, N. Y., to become associated with Mr. L. W. Burt, formerly City Engineer of Hartford, Conn., under the firm name of L. W. Burt & Son, with offices in Hartford.

Mr. W. C. Loree, General Superintendent of the Baltimore & Ohio R. R., at Pittsburg, Pa., has been appointed General Manager of the Cincinnati, Hamilton & Dayton Ry., with headquarters at Cincinnati, Ohio. He is succeeded as General Superintendent by Mr. E. A. Peck, formerly Superintendent of the Pittsburg Division.

Messrs. John M. Farley, M. Am. Soc. C. E., and P. L. Braunworth, Assoc. M. Am. Soc. C. E., have formed a partnership under the firm name of Farley & Braunworth, for the general practice of sanitary and hydraulic engineering. In addition to the New York office, now at 527 Fifth Ave., long maintained by Mr. Farley, the firm will open another office at the Wilkinson Bldg., Trenton, N. J. Mr. Braunworth has for some years been Mr. Farley's principal assistant, stationed at White Plains, N. Y.

Mr. George Alfred Goodenough, for many years Associate Professor of Mechanical Engineering at the University of Illinois, has been promoted to Professor of Thermodynamics. Prof. Goodenough graduated from Michigan Agricultural College in 1891, and received the degree of Mechanical Engineer from the University of Illinois in 1900. He has been previously connected as instructor with the Michigan Agricultural College and the International Correspondence Schools. He has been with the University of Illinois continuously since 1899 in the Department of Mechanical Engineering.

Prof. Charles Russ Richards, M. Am. Soc. M. E., Dean of the College of Engineering of the University of Nebraska, has been appointed Professor of Mechanical Engineering in Charge of the Department, at the University of Illinois, effective Sept. 1, 1911. Prof. Richards graduated from Purdue University in 1890 and received the degree of Mechanical Engineer from the same institution in 1895. He has been with the University of Nebraska since 1892, when he was appointed Adjunct Professor of Practical Mechanics. The new Mechanical Engineering Laboratory at the University, dedicated on Jan. 18, 1911, was built and equipped under his direction. Prof. Richards is a member of the Society for the Promotion of Engineering Education, the Nebraska Academy of Science, the Sigma Xi, Tau Beth Pi and Sigma Chi fraternities. He has made several

contributions to technical literature, including a paper presented before the American Society of Mechanical Engineers on the heating value of corn. This was several years ago at a time when Nebraska farmers were using corn for fuel on the assumption that it was less expensive than coal.

Obituary.

Nathaniel Thayer, a railroad director and capitalist of Boston, Mass., died at his home in that city on March 21. He was a director of the New York, New Haven & Hartford R. R., the St. Louis & San Francisco R. R., the American Telephone & Telegraph Co., the United Steel Corporation and others. He was a member of the Corporation of the Massachusetts Institute of Technology.

Ferdinand J. Rochow, a mechanical engineer and inventor, died at his home in Brooklyn, N. Y., on March 16, at the age of 73 years. He was graduated from Jena University in Saxony, Germany. He came to this country about the time of the Civil War and was engaged in the construction of war vessels at the Morgan Iron Works of New York City. His inventions were in the field of rotary pumps, hoisting engines, printing presses, safety valves and devices for many other purposes. He was founder of the New York Technische Verein.

David H. Moffat, banker and railway builder, died at his apartments in Hotel Belmont, New York City, on March 18. He was on a business trip and had been ill but a few hours. He was born in Orange County, N. Y., in 1839. At the age of 15 years he was a messenger in a New York bank. From New York he went to Des Moines, Iowa, and later to Omaha, Neb., finally settling in Denver, Colo., when that city was but a collection of miners' shanties. Here he started in the stationery business but was soon engaged in mining and real estate and thus made a large fortune. He was widely known as the chief owner and financier of the Denver, Northwestern & Pacific Ry., often spoken of as the "Moffat Road." Earlier he was the promoter of the Denver & Rio Grande Ry. and President of that road from 1884 to 1891.

John B. McDonald, prominent as a railroad and general contractor, but chiefly noted as the builder of the first New York City subways, died at his home in New York on March 17. He was born in Ireland on Nov. 17, 1844. Some years later his father emigrated to this country and established himself as a contractor on the West Side of New York City. For many years he was a prominent politician and a member of the Board of Aldermen.

The son, John B. McDonald, received a common school education, and at the age of 18 years, through his father's influence, secured a position in the office of the Register of Deeds. Later he became a timekeeper on the construction of the Boyd's Dam, a part of the Croton water-supply system. From this position he rose to foreman and later to inspector of masonry on the New York Central & Hudson River R. R. tunnels above 42d St., New York City.

His first venture as a contractor was made on this work. Backed by his father he put in a bid for a subcontract and succeeded in fulfilling the work satisfactorily. After his father's death he went on with the business of the latter. He soon became widely known as a railroad contractor and constructed many miles of lines for Eastern railways. One of his most important achievements was the construction of the Baltimore Belt Line at a cost of $8,000,000. Another of his large contracts was for the entire construction of the Jerome Park Reservoir for the City of New York.

In January, 1900, Mr. McDonald was the successful bidder for the construction of the New York City subway system. He was an officer of the Interborough Rapid Transit Construction Co., which was formed by Mr. August Belmont to finance the work, and had personal supervision of the construction work to the time of its completion. In 1907 he was associated with W. J. Oliver in bidding for the construction of the Panama Canal.

Mr. McDonald is said to have been a quiet, unassuming man, with little to say, but a good listener. He was a man of great executive ability and attended personally to a multitude of details.

The funeral services were held in St. Patrick's Cathedral on March 20. Among the honorary pall bearers were Mr. Samuel Rea, First Vice-President of the Pennsylvania R. R., and Mr. August Belmont. At 10.30 a. m., when the services began, the electric power of the entire subway system was turned off for two minutes, as a mark of respect to the memory of the man whose skill and energy had so much to do with its successful completion.

Engineering Societies.

COMING MEETINGS.

AMERICAN ELECTROCHEMICAL SOCIETY.
April 6-8. Annual meeting at New York City. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Pa.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 15-18. Annual meeting at Chattanooga, Tenn. Secy., D. B. Sebastian, 721 La Salle Station, Chicago, Ill.

AMERICAN RAILWAY ASSOCIATION.
May 17. Semi-annual meeting at New York City. Secy., W. F. Allen, 24 Park Pl., New York City.

OHIO SOCIETY OF MECHANICAL STEAM AND ELECTRICAL ENGINEERS.
May 18-19. Annual convention at Youngstown, Ohio. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 23-25. Annual meeting at New York City. Secy., F. H. Wentworth, 87 Milk St., Boston, Mass.

AIR BRAKE ASSOCIATION.
May 23-26. Annual convention at Chicago, Ill. Secy., F. M. Nellis, 53 State St., Boston, Mass.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
May 23-26. Annual convention at Pittsburg, Pa. Secy., Richard Moldenke, Watchung, N. J.

INTERNATIONAL MASTER BOILERMAKERS' ASSOCIATION.
May 23-26. Annual convention at Omaha, Neb. Secy., H. D. Vought, 62 Liberty St., New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 29-June 2. Annual convention at New York City. Secy., T. C. Martin, 29 West 39th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 30-June 2. Annual convention at Pittsburg, Pa. Secy., Calvin W. Rice, 29 West 39th St., New York City.

UTAH SOCIETY OF ENGINEERS.—At the regular monthly meeting held March 17 in Salt Lake City, a paper entitled "Protection at High Tension Line Crossings" was presented by Mr. A. S. Peters.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—A paper entitled "The Upper St. Lawrence River—Its International History, Development of Navigation and Future Possibilities," by Henry Holgate, was read at the meeting in Montreal, March 16.

NEW ENGLAND RAILROAD CLUB.—Officers elected at the annual meeting March 15 at Boston, Mass., are as follows: President, John A. Droege, of Providence, R. I.; Vice-President, R. D. Smith, of Boston, Mass.; Secretary-Treasurer, Charles W. Sherburne, Boston, Mass.

NEW YORK ELECTRICAL SOCIETY.—The 300th meeting was held March 16 in the Hispanic Society's Building, on 156th St. near Broadway, New York City. Mr. F. O. Blackwell lectured on "Hydro-Electric Development in Mexico." After the meeting the Hispanic Society's museum was thrown open for inspection. The membership is now more than 800.

MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.—At the regular meeting on March 22, Mr. Vernon S. Moon presented a paper on "A Proposed Method of Interpreting the Elevations of All Portions of a Street Surface from the Established Grades." An excursion is to be made March 25 to the new plant of the Consolidated Gas Co., of New York, at Astoria, Long Island.

ENGINEERING SOCIETY OF WISCONSIN.—Officers were elected at the recent annual meeting in Madison, Wis., as follows: President, Fred. G. Simmons, Milwaukee; Vice-President, P. H. Commonway, Racine; Trustees, G. H. Randall, Oshkosh, and F. A. Vaughan, Milwaukee. Mr. W. G. Kirchoffer declined re-election as secretary and treasurer. The vacancy will be filled by action of the board of directors.

NATIONAL ELECTRIC LIGHT ASSOCIATION.—A public meeting will be held Saturday, April 8, at the Engineering Societies Bldg., under the auspices of the power transmission section, to consider and discuss the relation of the national and state governments to the conservation and utilization of water-power. Two sessions will be held, afternoon and evening, at which papers and addresses will be presented.

INSTITUTE OF OPERATING ENGINEERS.—A New York City branch was organized March 18 with an initial membership of 31. The branch officers elected were: Chairman, Willis Lawrence, Interborough Rapid Transit Co.; Secretary-Treasurer, W. P. F. Hill, Woman's Hospital; Chairman of Educational Requirements, F. C. Flickinger; Chairman of Apprenticeship Requirements, L. M. Glodell. Other branches of the institute have been already formed in Chicago, in Boston and in Yazoo, Miss. At a recent meeting of the branch at Yazoo, known as the "Col. Goethals Branch," papers were read on "Water Rheostats" and on "The Four-Cycle Gas Engine." The total membership of the institute is now 278.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—A paper on the "Economic Importance of the Farm Tractor," by L. W. Ellis, of La Porte, Ind., will be presented at the meeting in New York City April 11. Following Mr. Ellis's paper, Dr. Charles E. Lucke, of Columbia University, will give an illustrated talk on the mechanical equipment of farm tractors. Mr. Ellis believes there is a field for the mechanical engineer in the adaptation of agricultural machinery for use with tractors, in the development of suitable prime movers, and on large farms in the installation and management of machinery and power. His paper includes data obtained in a number of tests made to determine the coal, or gasoline, and water consumption of tractors.

MINING AND METALLURGICAL SOCIETY OF AMERICA.—The bulletins of this society are to be published with a view to their being bound. The current volume will be numbered IV., corresponding with the year of the society's existence. Hitherto, the bulletins have been printed with only a date and a serial number. The membership on March 1, 1911, was 200, with 14 applications not yet acted upon. The by-laws provide for an initiation fee of $25 to come into force after the membership reaches 250.

At the February meeting of the Philadelphia section, the committee on engineering ethics presented a preliminary report which was left before the society for discussion. The report was in the form of a list of rules for professional conduct under three chief headings, obligations to the profession, duties to the public and relations to employers and clients.

WESTERN SOCIETY OF ENGINEERS.—At a meeting held at the society's rooms in Chicago on March 15, Dr. W. F. M. Goss, Dean of the College of Engineering, University of Illinois, presented an interesting paper on "The Illinois Engineering Experiment Station in its Relation to the Public." The station was organized to conduct investigations of importance to engineers, and to the manufacturing, railway, mining, building and other interests of the state. It is in its eighth year. As one result of its work it has issued 44 bulletins; 16 of these relate to reinforced concrete and other building materials, 15 to fuel in boilers and gas producers, 3 to electric light, 2 to metal cutting and 2 to filing systems for engineering literature.

The value of the work of the station to the industrial interests of the state is well recognized. Information and assistance rendered to manufacturing and other interests helps to increase their stability, and to improve their output and efficiency, besides tending to better conditions of employment and employees. Whatever helps these interests is reflected in the improvement of the general welfare of the public.

The paper referred to the testing and research work of the station, and was illustrated by a number of lantern slides. In the discussion, Mr. E. E. R. Tratman (Associate Editor of Engineering News), referred to the investigations on brakeshoes as one small example of the value of the work. The material, the manufacture, the use and the fitting of the brakeshoe, and the relation of the brakeshoe to the wheel have all been investigated with great care. That the railways appreciate the value of the work is shown by their strong support and backing. But to the general public there are important results in improved safety of travel, and higher degrees of efficiency in manufacturing processes and in railway service. Mr. W. L. Abbott, Mr. A. Bement and Mr. W. E. Symons and Mr. O. P. Chamberlain also took part in the discussion on the general subject of the value of technical education and investigational work.

INTERNATIONAL CONGRESS OF APPLICATIONS OF ELECTRICITY.—An International Congress will be held at Turin, from Sept. 9-20, 1911, under the auspices of the Italian Electrotechnical Association during the International Exhibition of Industry and Labor. An honorary, an organizing and an executive committee have been organized and a preliminary program has been drawn up, every effort being made to give the meetings an international character. The plans for this Congress are aided by the fact that the International Electrotechnical Committee (the international electrical standardizing organization) will be convened at Turin Sept. 11-16 and during this time the official delegates of several nations, including most of the well known figures in the electrical world, will be assembled there. The organizing committee has secured the cooperation of the chairmen of the electrotechnical committees of the different countries in the selection of official papers. As the Congress intends to deal especially with applications of electricity, these papers will bear particularly on the practical side of the art. All papers will appear in the transactions in their original language; those in English, German and Italian will be accompanied by a French translation or summary. The preliminary program shows the following subjects for discussion: (1) Modern high-speed generators; (2) storage batteries; (3) generating plants feeding a network; (4) switchboards and substations for large systems; (5) underground high-tension networks; (6) research in abnormal potential rise; (7) automatic circuit breakers; (8) cooling of transformers; (9) converters and rectifiers; (10) frequency transformers; (11) influence of metallic-filament lamps; (12) three-phase variable-speed motors; (13) single-phase traction vs. three-phase; (14) high-tension direct-current traction vs. single-phase; (15) overhead line construction for electric railways; (16) electric furnaces; (17) sterilization of water by electricity; (18) meters; (19) government control of meters; (20) commercial measurement of power; (21) increasing the load factor of central stations; (22) electric submarine boats; (23) long-distance telephony; (24) wireless telephony; (25) automatic telephone exchanges; (26) secrecy in wireless telegraphy; (27) electric heating; (28) study of methods of taxing electricity; (29) government regulation of electric transmission; (30) electric power for agriculture; and (31) multiple telegraphy.